A New and Eaſy GUIDE to
The Use of the GLOBES;
AND THE
Rudiments of Geography.

WHEREIN

The Knowledge of the Heavens and Earth is made eaſy to the meaneſt Capacity: Firſt, by giving a conciſe Account of the Four Quarters of the World, with the Diſtance and Situation of the principal Iſlands, and inland Places; and Secondly, by the Solution of upwards of Seventy uſeful Problems, in *Geography*, *Aſtronomy*, *Navigation*, and *Dialling*.

In which are inſerted

FOUR uſeful TABLES.

- I. Shews the Latitude of the principal Places, and their Longitude from the Meridian of London.
- II. Shews the Number of Miles contained in a Degree of Longitude, at every Degree of Latitude.
- III. Shews where every Climate ends, with the Length of the longeſt Day at the End of each.
- IV. Shews the Right Aſcenſion, Declination, Latitude, and Longitude of the moſt eminent fixed Stars.

To the whole are ſubjoined

I. AN APPENDIX;

Containing a ſhort Account of the Solar System, and of the Comets and Fixed Stars:

II. A SUPPLEMENT;

Exhibiting a brief View of the Figure and Magnitude of the Earth, of the Nature of the Atmoſphere, of the Theory of the Tides, and a conciſe Syſtem of Chronology.

By DANIEL FENNING.

The SEVENTH EDITION.

CORRECTED AND IMPROVED, BY

JOSEPH MOON, Mathematician, Salisbury.

In this Edition is inſerted a View of the Copernican or True System of the Universe, and the Coelestial Globe, neatly engraved.

LONDON:
Printed for J. Johnson; G. G. and J. Robinson;
F. and C. Rivington; G. Wilkie; J. Scatcherd;
T. N. Longman; and C. Law.

1798.

DEDICATION.

To all public Tutors and Lovers of Mathematical Learning, eſpecially thoſe that I have had the Honour to inſtruct.

THE Study of the Uſe of the Globes is now become very common among Gentlemen, in compariſon of what it was ſome few years ago. There are Numbers that cannot bear the Thought of going through a tedious and regular Courſe of Geometry, Trigonometry, Algebra, &c. yet find a great Pleaſure in learning upon the Globes; and this I imagine is becauſe the Knowledge of them is ſo readily attained. Nothing is eaſier than practical Geography, commonly called The Uſe of the Globes, becauſe no other Branch of Learning is previouſly neceſſary. He that can read well, may arrive at the Knowledge of them almoſt as ſoon as another that is well acquainted with Figures.

Some of you may think it a Preſumption in me to publiſh a Book upon the

Uſe of the Globes, when ſo many are already extant upon the ſame Subject, and eſpecially as Dr. Harris's is ſo much uſed: But many of you may remember I have been obliged to explain him to you; and you have owned he is not ſo clear in many of the Problems as could be wiſhed. Beſides, his is a general Treatiſe of the Rudiments of Aſtronomy, mixt with the Uſe of the Globes; but this little Tract, except in the Appendix, treats of nothing of that ſort, but goes through a Series of Problems (as you will ſee more particularly in the Preface) Step by Step; and as every Problem has an Anſwer, you cannot be at a Loſs to know when you are right.

As I have endeavoured to render it both eaſy and uſeful in all public Academies, &c. as well as to private Gentlemen, you will, no Doubt, excuſe ſome few Errors; and in giving it a kind Reception you will do me great Honour, and very much oblige,

Your humble Servant,

D. FENNING.

PREFACE.

Kind Reader,

I Here preſent you with a ſmall Treatiſe of Geography, and The Uſe of the Globes. The Geographical Part, you may naturally ſuppoſe, I borrowed from different Authors, who, no doubt, were obliged in the ſame Manner to borrow their Accounts from previous Publications: And this is always allowable in Hiſtory, though not in every part of Learning.

Beſides, many Hundreds may happen to light on one Book, who may never ſee another on the ſame Subject; therefore a Number of Books can never fail of being ſerviceable to the Public; and if every Author makes but an Improvement in what he takes in Hand, he does well, and the Reader is in ſome Meaſure obliged to him. It may be aſked what improvements can be made here, ſince there are ſo many large Volumes upon the Subject, and theſe written by the moſt eminent Authors? I anſwer, that as my Knowledge is not ſufficient, ſo my Intention never could be to give a better Account of Things than they have done. But the point in Hand is, whether I have not drawn the Work into a narrower Compaſs, ſo as not to burthen the Memory, and yet, at the ſame Time, made it ſo diſtinct as to convey a clear and ſatisfactory Idea of what is both neceſſary and uſeful to every common Reader. If I have in any Reſpect done this, I have done as much in the Geographical Part as I intended, and more; for my Deſign at firſt was only to treat of the Deſcription and Uſe of the Globes; therefore, I hope, if any Errors have crept into the firſt Part, they will be pardoned. For

Some Authors differ from others. Thus Gordon ſays, that the Metropolis of Maryland is Baltimore, in Honour of Lord Baltimore; but Taylor and Dampier ſay Annapolis Royal is the Capital.—Which of theſe is right, I cannot determine; only this I ſay, that Gordon ſeems to be right according to Hiſtory, and Taylor according to Cuſtom; becauſe Annapolis-Royal is the chief Place of Traffic and Buſineſs. But I leave this to better Judges, and will now give ſome Account of the Work in general.

Dialogue I. II. III. and IV. Contain a ſhort and eaſy Account of the Situation of the principal Places in the known World, with their Diſtance from London, in an Arch of a great Circle.

Dial. V. and VI. Contain a general Deſcription of the Globes, with the Nature and Property of the Sphere, and the different ſituation of the Inhabitants of the World in reſpect of each other.

Dial. VII. An explanation of the moſt uſeful Terms in Geography; to which are annexed, Four uſeful Tables.

1. Shews the Latitude of the principal Places, and their Longitude from the Meridian of London.

2. Shews the Number of Miles contained in a degree of Longitude, at every Degree of Latitude.

3. Shews where every Climate ends, with the Length of the longeſt Day at the End of each.

4. Shews the right Aſcenſion, Declination, Latitude, Longitude, &c. of the moſt remarkable fixed Stars, taken from Senex's Globes.

Dial. VIII. Contains 77 Problems performed by the Globes, many of which are very uſeful in ſhewing the Nature of Spherical Triangles, and are applied to Navigation, Dialling, &c. and I have not only given you the Rule to work them by, but have given you the Anſwers to the Problems, that you may know when you are right. If indeed your Anſwer be not exactly the ſame with mine in Reſpect to Minutes, never mind that; for I have taken the neareſt Quarter of a Degree for this Part of the Anſwer: Thus, if it were 12 Minutes I call it 15 or ¼ of a Degree; I have done the ſame when it is 20 Minutes; but if it be near ½ a Degree on the Quadrant, I call it 30 Minutes; and this I have done on purpoſe to avoid puzzling the Learner, becauſe we cannot gueſs to a minute or two on the Quadrant, and Globes will often differ for want of good Appendants.

As for the diſtance of Places from London, I have taken it from no Book or Perſon; and though I agree with Echard and ſeveral others, in Reſpect of Degrees, yet I differ from them in my Anſwer in Miles, moſt of them allowing but 60 miles or minutes to a Degree, whereas I have counted 69½ to a Degree. If you cannot multiply the Degrees by 69½, then multiply by 70, and take ½ the Number of Degrees out of that Product; this is the ſame as multiplying by 69½,

In fine, I have endeavoured to render this Book as uſeful as I could, and I am perſuaded any Body may (of himſelf) learn the Uſe of the Globes by it, if he will but take the Trouble to learn the Signs and Terms previous to ſuch an Undertaking.

Arts and Sciences are not to be learned by mere Reading only; there muſt be ſome Practice, or elſe the bare Reading will never make a complete Artiſt; and if ſo, how can it be expected that he ſhould become a Proficient that never reads at all?

It is not having a Thouſand Volumes in your Library, that will convince the World you underſtand them; for without a little Pains, you never will be a Jot the wiſer in the practical Part of the Mathematical Studies.

But as for the Uſe of the Globes, it is ſo plain and ſo eaſy, that moſt Perſons eſteem it a Pleaſure, rather than a Labour; and as the Knowledge of them is very uſeful as well as entertaining, I would recommend it to young Gentlemen in general, as they may learn the Uſe of them without Pains, and, in ſhort, without Loſs of Time.

To render the Work ſtill more perfect, I have added an Apppendix, containing a ſhort Account of the Solar Syſtem and of the Comets and fixed Stars.

I am, kind Reader,

Your humble Servant, and Well-wiſher,

D. FENNING.

ADVERTISEMENT

TO THE

SIXTH EDITION.

THE Editior of the preſent edition having made uſe of this book in his School many years, (it being the beſt practical treatiſe of the kind extant) became thereby a better judge of what was wanting to render it more complete. And, by correcting errors, ſupplying deficiencies, illuſtrating obſcurities, expunging what was either obſolete, ſuperfluous, or unſcientific, and ſubſtituting recent and intereſting matter in its ſtead, he hopes he has ſo far improved this impreſſion as greatly to facilitate the progreſs of the learner.

The additional Tables, page 79 and 80, it is preſumed, are more correct than any others of the kind extant.

Table IV, of the Stars, being now corrected, both in Right Aſcenſion and Longitude, to the beginning of the year 1792; if thoſe who uſe old Globes ſhould not find the Stars exactly in the ſituation there mentioned, the fault is to be attributed to the Globes and not to the Table.

In fine, if an exact compariſon be made, by a candid and judicious perſon, between this and the laſt edition, the editor has no doubt but the ſuperiority in favour of the preſent will be obvious.

☞ The Notes at the bottom of pages 56, 59, 70, 83, 87, 101, 115, 124, 142, and Prob. and Note 118 and 119, are by the Editor,

JOSEPH MOON.

TO THE

PUBLIC.

WE whoſe names are hereunto ſubſcribed, having peruſed this epitome of Geography, are of opinion, that it is very well adapted to the capacity f all ſuch as, without much previous reading, would ſpeedily acquire a true notion of the ſituation of the principal places in the known world. And for the variety of Problems it contains, and which are ſo clearly ſet forth, and ſo plainly demonſtrated, we beg leave to recommend it to every learner, as the moſt uſeful book extant. Witneſs our hands,

Rev. J, Warneford, of *Darking, Surry.*
George Coles, *Surveyor.*
Henry Deacon, *Accompſtant.*
Edward Griffiths, *Surveyor and Accompſtant.*
Anthony Gilbert, *Surveyor.*
Abraham De Lire, *Philo Math.*
John Quant, *Teacher of the Mathematics.*
William Simſon, *Philo Math.*
John Smythe, *Accompſtant.*
James Thurſton, *Ditto.*

To the PUBLISHER *of* MR. FENNING'S NEW USE *of the* GLOBES.

Darking, May 9, 1785.

SIR,

THE Alterations you propoſe introducing in a New Edition of Fenning on the Globes, will be an additional Recommendation of that uſeful little Treatiſe, to

Your obedient Servant,

J. WARNEFORD.

TO THE

RECOMMENDERS.

GENTLEMEN,

I Return you hearty thanks for your kindneſs in honouring me with your names to this ſmall Treatiſe. Your aſſiſtance in diſcovering any errors that I have omitted correcting, will ſtill further oblige,

GENTLEMEN,
Your very humble Servant,
DANIEL FENNING

DIRECTIONS *to the* Bookbinder *for placing the* MAPS *and* CUTS.

Map of the World - - fronting the Title Page.
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A NEW AND EASY

GUIDE

TO THE

USE *of the* GLOBES.

DIALOGUE I.

Between PHILO, *a Tutor, and* TYRO, *a Pupil, concerning* GEOGRAPHY *in general.*

SECT. I.

Tyro. YOU have already been ſo kind, dear *Philo*, as to inſtruct me in the principles of common arithmetic, and the rudiments of algebra, and you promiſed to inſtruct me alſo in the uſe of the globes: if therefore it be agreeable to you, I ſhall be very glad to begin immediately.

Philo. With all my heart; it pleaſes me much to ſee you delight in any thing of this ſort, rather than ſpend your time in idleneſs, which is the parent of miſchief; I am therefore as ready to teach you as you are willing to be taught: but I think it will not be amiſs to give you firſt a little notion of geography, as it will not only qualify you the better for this undertaking, but will be a great help to you for the more ready underſtanding whatever you read.

Tyro. I thank you, ſir; for indeed I have very little notion of, and ſcarce know what you mean by geography.

Philo. Geography is a Science which explains the properties of the earth, both in reſpect to land and water; for of theſe two parts the terraqueous globe is compoſed.

Tyro. You ſay the earth is a globe: I ſhould be glad to be informed how it is poſſible to know of what figure the earth really is.

Philo. The roundneſs of the earth may be proved by a variety of arguments: 1. When we are on board a ſhip at ſea, we may be out of ſight of land, when the land is near enough to be viſible, if it were not hid from our eye by the convexity of the water. In this caſe, the tops of hills, cliffs, ſteeples, towers, &c. firſt appear to our view, next the buildings, and laſt of all the ſhore; which can proceed from nothing elſe but the roundneſs of the earth, whereby the lower objects are longer hid from the ſight, than thoſe which are higher. 2. The higher the eye is, the farther will the view be extended: it is very common for ſeamen, on the top of the maſt, to diſcover land, or ſhips, at a greater diſtance than thoſe can do who ſtand upon the deck; the object being hid from the latter by the convexity of the water. 3. When we ſtand upon the ſhore, the higheſt part of a ſhip is viſible at the greateſt diſtance; if a ſhip be going from us out to ſea, we ſhall continue to ſee the maſt, after the hull or body of the ſhip diſappears, and the top of the maſt will be ſeen longeſt. But if the ſurface of the ſea were a flat, every part of an object would be equally viſible; and not the higheſt, but the largeſt part of an object, would be viſible at the greateſt diſtance, ſo that we ſhould be able to ſee the hull of a ſhip farther off than the maſt: But this is contrary to experience; conſequently the earth is round. 4. The convexity of the water may be ſeen in calm weather, and where the fluid is unruffled by the agitation of the ſtream, provided it be a mile or two in a ſtraight line, for a little boat upon the water may be ſeen by a perſon whoſe eye is a ſmall height above the water; but if he ſtoops down and lays his eye near the ſurface, he will find that the boat is covered by the convexity of the water. 5. Several navigators have ſailed quite round the earth; not in an exact circle, the winding of the ſhores preventing them from ſailing on a direct courſe; but by ſailing continually to the weſtward, they have reached the place from whence they at firſt departed. This was performed by Magellan, Cavendiſh, Sir Francis Drake, Lord Anſon, Bougainville, Commodore Byron, the Captains Carteret, Wallis, Cook, and others. 6. All the appearances of the heavens, both at land and ſea, are the ſame as they would be were the earth a globe, which proves that it really is ſuch. And, laſtly, eclipſes of the moon, which are cauſed by the ſhadow of the earth falling on that planet, demonſtrate that the earth is of a globular figure; for this ſhadow is always circular, whatever ſituation the earth may be in at that time: now a body muſt be globular which always caſts a circular ſhadow. Nor are the little unevenneſſes on the earth's ſurface, ariſing from hills and valleys, any material objection to its being conſidered as a round body; becauſe the higheſt mountains bear a leſs proportion to the bulk of the earth, than the little riſings on the coat of an orange bear to that fruit; or a grain of ſand to an artificial globe, of nine inches diameter: and accordingly, we find that the mountains and valleys on the ſurface of the earth, cauſe no irregularities in the ſhadow, during a lunar eclipſe; the circumference thereof being even and regular, and appearing as if caſt by a body truly globular.

Tyro. I am convinced, from the reaſons you have given, that the earth is round; and ſhould be glad to know the methods that have been taken to meaſure it, or find the dimenſions of this globe.

Philo. The methods made uſe of to meaſure the earth are very plain and eaſy to be underſtood. But it will be neceſſary to obſerve, that every great circle, and conſequently the circumference of the earth, is divided into 360 equal parts, called degrees, and every degree into 60 equal parts, called minutes, &c.

Tyro. This I have already learned in common arithmetic; but ſhould be glad to know why every circle contains neither more nor leſs than 360 degrees.

Philo. It was neceſſary to give the preference to ſome number; and probably that of 360 was fixed upon for this reaſon, that it admits of ſeveral convenient diviſions as well by the figure 2 as 3. Thus the half is 180, the quarter 90, and the half quarter 45. Alſo the third of 360 is 120, the third of which again is 40. Few other numbers can boaſt of this advantage, eſpecially as every number in both the above diviſions is alſo further diviſible by five.

Tyro. You have ſufficiently ſatisfied me in this particular; and now I think I am capable of underſtanding the method made uſe of in meaſuring the earth.

Philo. As every circle is divided into 360 degrees, if at two places ſituated North and South of each other, the altitude of the ſun be taken on the ſame day at noon, and the ſun be found to be one degree nearer to the zenith at one place than at the other, thoſe two places are one degree aſunder. Now if the diſtance between theſe two places be meaſured by a chain or otherwiſe, we ſhall know the length of a degree, and conſequently of any part of a degree, in Engliſh meaſure. This has been done by ſeveral geographers, particularly by our countryman Mr. Richard Norwood, who, in the year 1635, obſerved the difference of latitude, and meaſured the diſtance between London and York.

By which it appeared that 367,200 Engliſh feet, or 69 miles and a half, and 14 poles, make a degree. Hence the whole circumference of the globe will be 25,020, and its diameter 7,970 Engliſh miles, reckoning 69 and a half to a degree. If the odd poles be taken into the account, the circumference will then be 25,035 miles and 240 poles.

The map of the world, prefixed to this work, will give you a much better idea of the world itſelf, than the beſt verbal deſcription. It repreſents the artificial globe taken out of its horizon, ſqueezed flat, cut through, and the two hemiſpheres placed cloſe to each other.

Tyro. Into how many parts is the earth divided?

Philo. Into 4 parts, or quarters; viz. 1. Europe, 2. Aſia, 3. Africa, and 4. America.

Tyro. What are the other nominal parts of the earth; or how is it yet further divided in relation to land and water?

Philo. It is divided into 10 different parts; 5 belonging to land; viz. 1. A continent. 2. An iſland. 3. A promontory or cape. 4. A peninſula. And, 5. An iſthmus. The other 5 belong to water; viz. 1. An ocean. 2. A lake. 3. A bay. 4. A gulf. And, 5. A ſtrait. Theſe anſwer to each other, as more plainly appears by the following deſcription.

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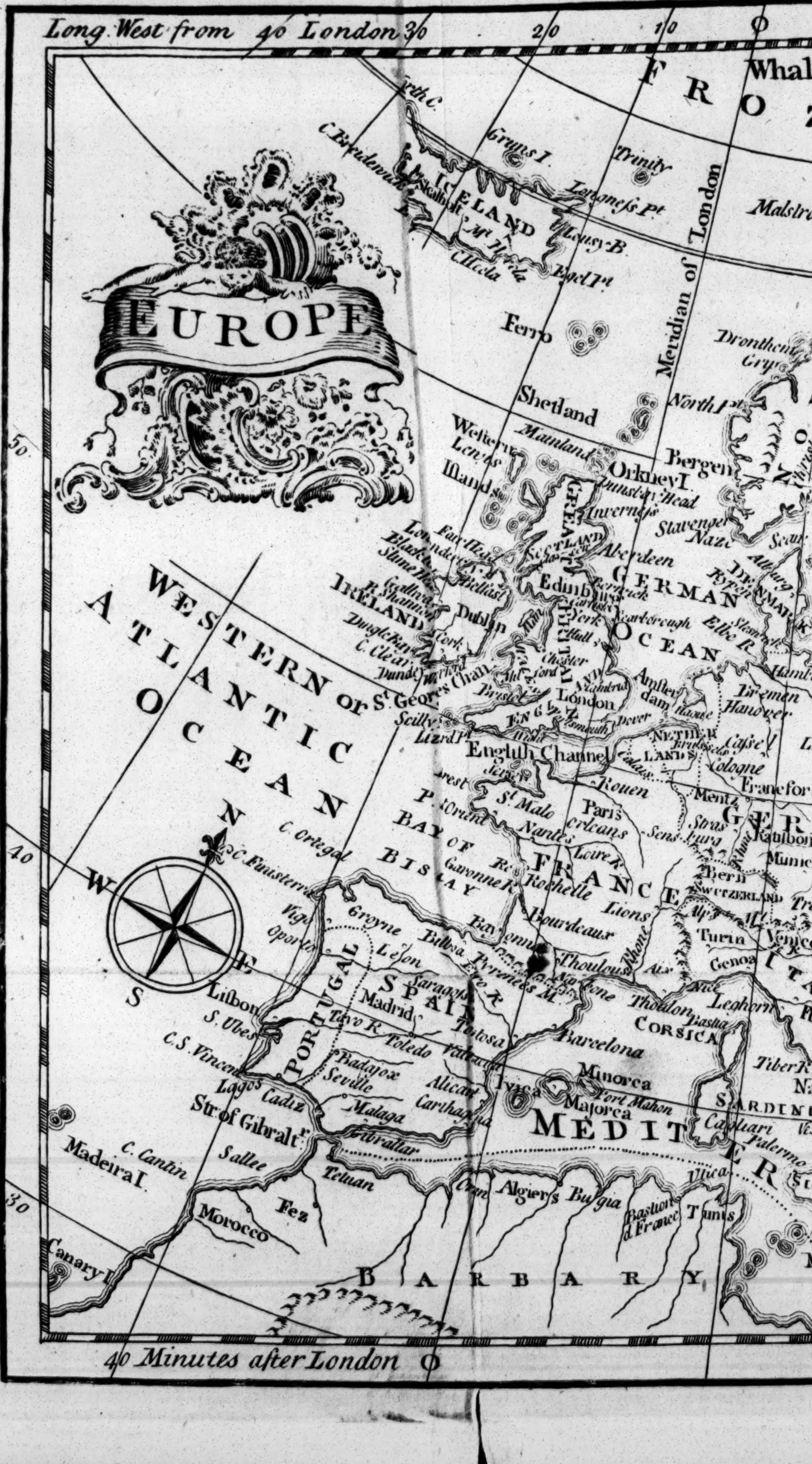
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Berwick
Carlisle
York
Hull
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GREAT BRITAIN
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GERMAN OCEAN
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WESTERN OR ATLANTIC OCEAN
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Nice
Leghorn
Bastia
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PORTUGAL
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C. S. Vincent
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Alicant
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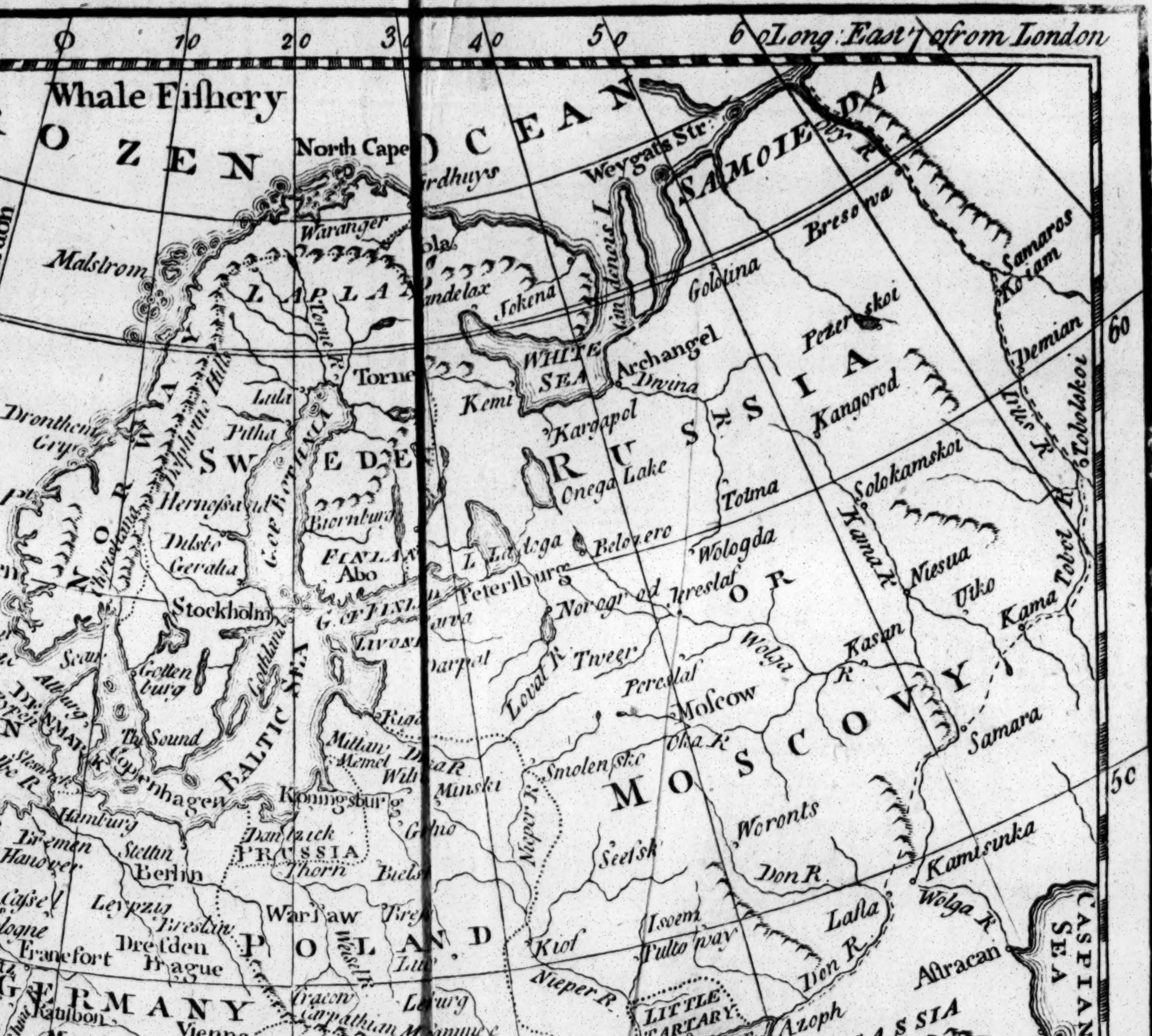
Iyica
Minorca
Port Mahon
Majorca
Lagos
Cadiz
Malaga
Str. of Gibralt.
Gibraltar
MEDIT
Sallee
Tetuan
C. Cantin
Madeira I.
Oran
Algiers
Bugia
Bastion de France
Tunis
Utica
Fez
Morocco
Canary I.
BARBARY
SARDINIA
Cagliari
Palermo
Tiber R.



J. Gibson Sculp

LAND.	WATER.
1. A continent is a large tract, or vaſt extent of main land, not ſeparated by any ocean. Thus Europe, Aſia, Africa, &c. are continents.	1. An ocean (or ſea) is a large extent or collection of waters, not divided by land; ſuch as the Atlantic or Weſtern Ocean, the Indian Ocean, &c.
2. An iſland is a tract of land ſurrounded with Water; as Great Britain, Ireland, Jamaica, Madagaſcar. &c.	2. A lake is a tract of water ſurrounded by land; as the lake of Geneva, the Dead Sea, the Caſpian Sea, &c.
3. A promontory, or cape, is a portion of land running far into the ſea; as Cape Verde, Cape of Good Hope, &c.	3. A bay is a portion or part of the ſea running far up the main land; as the Bay of Biſcay, Bay of Bengal, &c.
4. A peninſula is a part or portion of the earth almoſt ſurrounded with water, ſave only a part or narrow neck of land which joins or unites it to a continent; as Jutland, the Morea, Crim Tartary, &c.	4. A gulf is a part of the ocean almoſt ſurrounded with land, ſave ſome ſtrait or narrow gut of water, by which it has a communication with the ocean; as the Gulf of Perſia, &c.
5. An iſthmus is a narrow part of land, by which a peninſula is joined to a continent or main land; as the iſthmus of Darien, which joins North and South America together; the iſthmus of Corinth, &c. &c.	5. A ſtrait is a narrow paſſage or part of the ſea, which joins one ſea to another; as the ſtraits of Gibraltar, which join the Mediterranean Sea to the Atlantic Ocean; the ſtraits of Babelmandel, &c. &c.

SECT. II

A further Deſcription of the four Quarters of the World; and,

I. *Of* EUROPE.

Tyro. WHAT are the principal parts into which Europe is divided?

Philo. They are 9 in number; viz. 1. Scandinavia (which comprehends Sweden or Swedeland, Denmark, and Norway). 2. Muſcovia, or Ruſſia. 3. France. 4. Germany. 5. Poland. 6. Spain. 7. Portugal. 8. Italy. And 9. Turkey.

Tyro. Pray give me ſome ſhort account of theſe with reſpect to their ſituation on the globe, and to each other.

Philo. That I will, my dear Pupil; but it muſt be a ſhort account indeed; juſt enough to give you a little idea of the matter, and qualify you the better for reading and converſation. But the map of Europe, which you ſee before you, will be of the greateſt uſe; and the ſituations of places will be much eaſier obtained from thence than from any verbal deſcription.

I. *Of* SCANDINAVIA.

Tyro. What do you mean by Scandinavia; and how, or whereabouts is it ſituate?

Philo. Scandinavia is a large country, ſituate between 54 and 72 degrees of N. latitude; under which name are comprehended the kingdoms of Sweden, Denmark, and Norway, as was ſaid before.

1. SWEDEN.

Tyro. How is Sweden ſituate?

Philo. Sweden is bounded on the N. and W. by Norway, on the E. by Muſcovy, and on the S. by the Sound, and part of the Baltic. Its metropolis or chief town is Stockholm, whoſe diſtance from London is about 12¾ degrees, or 886 miles N. E. The longeſt day in the moſt northern parts of this country is between 2 and 3 months, and the ſhorteſt in the moſt ſouthern parts is 6½ hours.

2. DENMARK.

Tyro. How is Denmark ſituate?

Philo. Denmark is bounded on the N. by the Sound, on the E. by the Baltic, on the S. by part of Germany, and on the W. by the German Ocean. Its metropolis is Copenhagen, whoſe diſtance from London is 8½ degrees, or 590 miles N. E. The length of the longeſt day in the moſt northern parts of this country is about 17½ hours; and the ſhorteſt in the moſt ſouthern 7 hours long.

3. NORWAY.

Tyro. How is Norway ſituate?

Philo. Norway is bounded on the N. W. and S. by part of the main Ocean, and on the E. by Sweden, Its metropolis is Bergen, whoſe diſtance from London is about 9¼ degrees, viz. 642 miles N. by E. The length of the longeſt day in the moſt northern parts is above 2 months, and the ſhorteſt in the moſt ſouthern about 6 hours.

II. *Of* MUSCOVY *or* RUSSIA.

Tyro. How is Muſcovy ſituate.

Philo. Muſcovy is bounded on the N. by the great Northern Ocean, on the E. by Tartary, on the W. by Sweden and Poland, and on the S. by the Black Sea and Georgia. Its length is computed to be about 1500 miles, and breadth about 1100 miles. Its chief province is Muſcovy, and its ancient metropolis Moſcow, whoſe diſtance from London is about 23 degrees; viz. nearly 1600 miles N. E. and obout 800 E. of Cracow. Its preſent metropolis is Peterſburgh. The longeſt day in the moſt northern parts of this country is about 2 months, and the ſhorteſt in the moſt ſouthern is about 8½ hours.

III. *Of* FRANCE.

Tyro. How is France ſituate?

Philo. France (called Gallia, or the country of the ancient Gauls) is bounded on the N. by the Engliſh channel, on the E. by Germany, on the S. by part of Spain and the Mediterranean Sea, and on the W. by the Bay of Biſcay. Its length is computed to be 600 miles, and its breadth 500. Its metropolis is Paris, whoſe diſtance from London is about 3 degrees S. S. E. viz. 210 miles. The length of the longeſt day in the moſt northern part of this kingdom is about 16¼ hours, and the ſhorteſt in the moſt ſouthern part 9 hours.

IV. *Of* GERMANY.

Tyro. How is Germany divided?

Philo. Germany is in length about 700 miles, and breadth about 600. It is divided into three parts; viz. Holland, Flanders, and Upper Germany.

1. HOLLAND.

Tyro. How is Holland ſituate?

Philo. Holland is bounded on the N. and W. by the German Ocean, on the E. by Upper Germany, and on the S. by Flanders. Its metropolis in the N. part is Amſterdam, whoſe diſtance from London is about 210 miles N. E. and Rotterdam in the S. which is about 190 E. from London.

2. FLANDERS, *or the* AUSTRIAN NETHERLANDS.

Tyro. How is Flanders ſituate?

Philo. Flanders is bounded on the N. by Holland, on the E. by upper Germany, on the S. by France, and on the W. by the German Ocean. It has many fair and rich provinces, the metropolis of which is Bruſſels, whoſe diſtance from London is about 180 miles E.

3. UPPER GERMANY.

Tyro. What do you mean by upper Germany, and how is it ſituate?

Philo. Upper Germany, including Switzerland, is that part of Germany properly ſo called, and part of ancient Gaul and Italy. It is bounded on the N. by Denmark and part of the Baltic, on the E. by Poland, on the S. by Italy, and on the W. by France. Its metropolis is Vienna, whoſe diſtance from London is about 760 miles S. E.

V. *Of* POLAND.

Tyro. How is Poland ſituate?

Philo. Poland is bounded on the N. and E. by Muſcovy, on the S. by Hungary, Tranſylvania and Turkey, and on the W. by Upper Germany. Its length is about 700 miles, and breadth about 680. Its metropolis is Warſaw, whoſe diſtance from London is 13 degrees; viz. about 900 miles E. The longeſt day in the moſt northern part of this country is about 17½ hours, and the ſhorteſt in the moſt ſouthern about 8¼ hours.

Tyro. Is there any thing elſe remarkable with regard to Poland?

Philo. The kingdom of Poland has been ſeized and divided by the late empreſs of Ruſſia, the emperor of Germany, and the king of Pruſſia.

VI. *Of* SPAIN.

Tyro. How is Spain ſituate?

Philo. Spain, formerly called Iberia or Heſperia, is bounded on the N. by the Pyrenean Mountains and the Bay of Biſcay, on the E. by the Mediterranean, on the S. by the Straits of Gibraltar, and on the W. by Portugal and the Atlantic Ocean. Its metropolis is Madrid, whoſe diſtance is better than 11 degrees; viz. about 780 miles S. by W. of London. The longeſt day in the moſt northern part of this kingdom is about 15¼ hours, and the ſhorteſt in the moſt ſouthern part is about 9½ hours.

VII. *Of* PORTUGAL.

Tyro. How is Portugal ſituate?

Philo. Portugal is bounded on the N. and E. by Spain, and on the S. and W. by the Atlantic Ocean. Its metropolis is Liſbon, whoſe diſtance from London is better than 14 degrees S. W. by S. viz. about 980 miles. The longeſt day in the moſt northern parts of this country is about 15 hours, and the ſhorteſt in the moſt ſouthern about 9¼ hours.

VIII. *Of* ITALY.

Tyro. How is Italy ſituate?

Philo. Italy is bounded on the N. by part of Germany, on the N. E. by the Adriatic Sea, or Gulf of Venice, and on the S. and W. by the Mediterranean and part of France. Its metropolis is the city of Rome, the ſeat of papacy, and, before the late revolution effected by the French, the reſidence of the Pope. Its diſtance from London is nearly 13 degrees S. E. viz. about 903 miles.

IX. *Of* TURKEY *in* Europe.

Tyro. How is Turkey ſituate?

Philo. Turkey is bounded on the N. by Ruſſia and Poland, on the E. by the Black Sea, and part of Turkey in Aſia, on the S. by the Mediterranean, and on the W. by the Gulf of Venice, and part of Germany. It lies between 36 and 49 degrees N. latitude. Its metropolis is Conſtantinople, whoſe diſtance from London is 22½ degrees; viz. about 1564 miles E. by S.

The length of this country is about 1000 miles, and its breadth about 900. The longeſt day in the moſt northern parts is about 16 hours, and the ſhorteſt in the moſt ſouthern about 9¼ hours.

The Diviſion of TURKEY.

Tyro. Is not Turkey divided into different parts?

Philo. Yes, into many, but chiefly into five; viz. 1. Hungary. 2. Greece. 3. Romania. 4. Crim and Little Tartary. 5. The Danubian provinces.

1. HUNGARY.

Hungary, though now chiefly ſubject to the emperor of Germany, is notwithſtanding a part of Turkey. It is bounded on the N. by part of Poland, on the E. by Tranſilvania, on the S. by Sclavonia, and on the W. by Auſtria. Its chief city is Preſburg, whoſe diſtance from London is about 810 miles S. E.

2. GREECE.

Tyro. How is Greece ſituate?

Philo. Greece is bounded on the N. by the Danubian provinces, on the E. by Romania and the Ægian Sea, called the Archipelago, on the S. and W. by the Mediterranean. Its chief cities are Athens, Corinth, and Thebes. Corinth is about 54 miles W. of Athens; and Thebes, or Stives, is about 45 N. W. of Athens.

3. ROMANIA.

Romania is bounded on the N. by Bulgaria, on the E. by Greece, on the S. by the Archipelago and the Sea of Marmora, and on the W. by the Black Sea. Its chief cities are Conſtantinople, the capital, and Adrianopole, ſituate about 146 miles N. W. of Conſtantinople.

4. LITTLE TARTARY.

Tyro. How are Crim and Little Tartary ſituate?

Philo. They are bounded on the N. by part of Muſcovy, on the E. by Georgia, on the S. by the Black Sea, and on the W. by Poland.

The metropolis is Kaffa; it ſtands near the Euxine Sea, about 400 miles N. E. of Conſtantinople, and about 750 miles S. of Moſcow.

The Turks have lately been deprived of Crim Tartary by the Ruſſians, who have made themſelves maſters of this part of their dominions.

5. *Of the* DANUBIAN *Provinces.*

Tyro. What do you mean by the Danubian provinces? and how are they ſituate?

Philo. They are ſo called, becauſe they chiefly lie upon, or near the Danube, which riſes in the Black Foreſt in Germany, and falls into the Euxine Sea.

Tyro. How many provinces are there?

Philo. Eight; 1. Tranſilvania. 2. Walachia. 3. Moldavia. 4. Bulgaria. 5. Servia. 6. Boſnia. 7. Sclavonia, 8. Croatia.

SECT. III.

Of the EUROPEAN *Iſlands*; *and*,

I. *Of* ENGLAND.

Tyro. HOW is England ſituate?

Philo. England (called alſo Anglia, Britannia, or Albion) is bounded on the N. by Scotland, on the E. by the German Ocean, on the S. by its own Channel, which parts it from France, and on the W. by St. George's or the Iriſh Sea: it lies between 50 and 56 degrees N. latitude: its length is about 360, and breadth about 300 miles: its metropolis is London.

This kingdom contains 38 counties, beſides Middleſex and Cheſhire; this laſt being a county palatine, having the privilege of its own particular judges, councellors, &c. It has two univerſities, Cambridge and Oxford, 24 biſhoprics, and two archbiſhoprics.

Tyro. Are theſe all the counties in England?

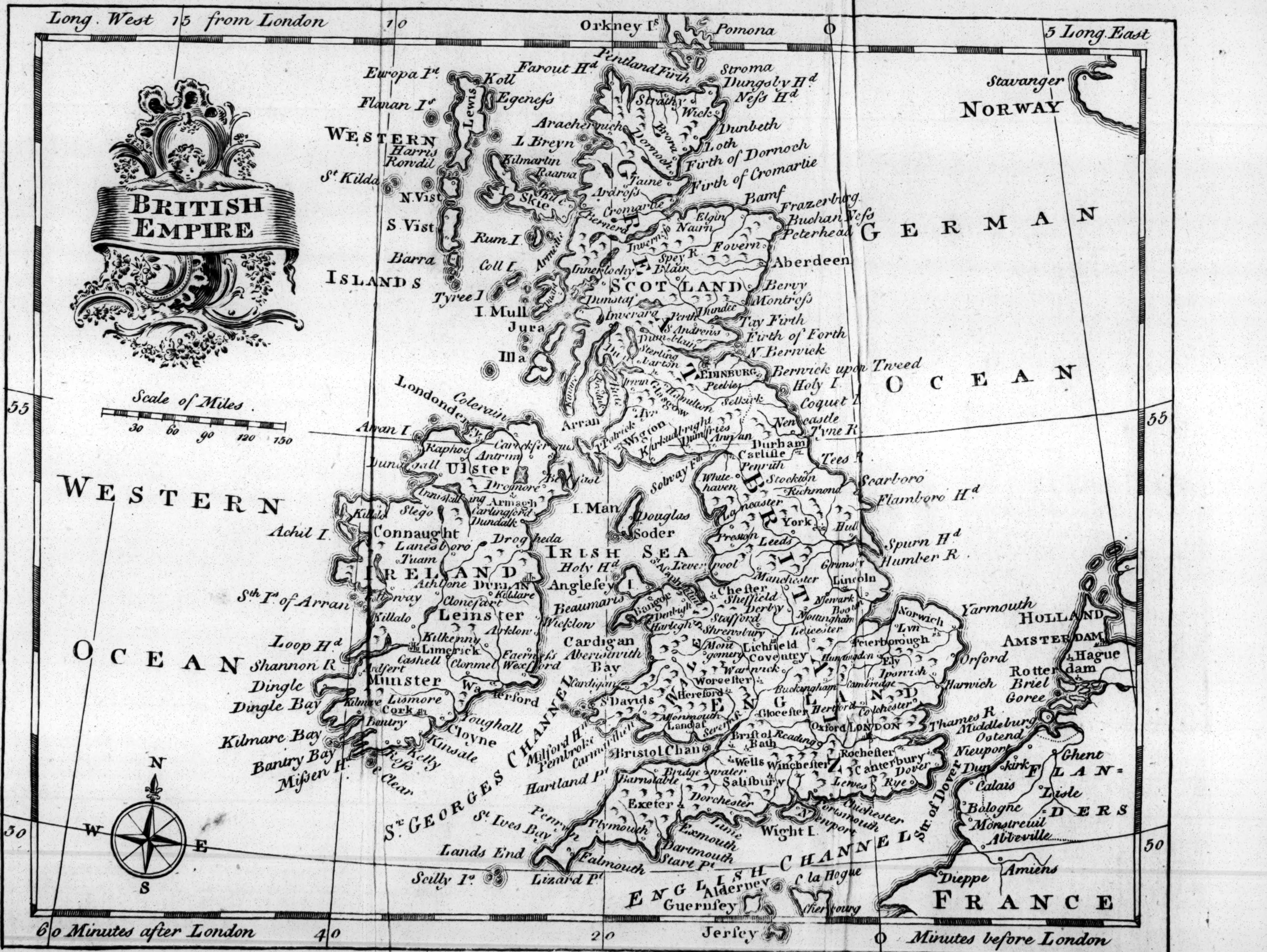
Philo. Yes, excluſive of Wales, which has four circuits, twelve counties, and four biſhoprics. The longeſt day in the moſt northern parts is about 17½ hours, and the ſhorteſt in the moſt ſouthern about 8 hours.

II. *Of* SCOTLAND.

Tyro. How is Scotland ſituate?

Philo. Scotland (called alſo Caledonia) is bounded on the N. by the Atlantic Ocean, on the

E. by



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E. by the German Sea, on the ſouth by England, and on the W. by the Iriſh Sea and the Atlantic Ocean. It lies between 54 and 59 degrees N. latitude. Its length is about 300, and breadth about 150 miles, and its metropolis is Edinburgh, whoſe diſtance from London is nearly 4¾ degrees; viz. about 330 miles N. W. The longeſt day in the moſt northern part of this country is about 18½ hours, and the ſhorteſt day in the moſt ſouthern 6½ hours.

III. *Of* IRELAND.

Tyro. How is Ireland ſituate?

Philo. Ireland (called by ſome Britannia Parva, and by others Hibernia) is bounded on the N. W. and S. by the Atlantic Ocean, and on the E. by St. George's Channel and the Iriſh Sea. It lies between 51 and 56 degrees of N. latitude. The length is about 290, and breadth about 150 miles. Its metropolis is Dublin, which is diſtant from London nearly 4¼ degrees; viz. about 295 miles N. W. The length of the longeſt day in the moſt northern part is about 17½ hours, and the length of the ſhorteſt in the moſt ſouthern about 7¾ hours.

SECT. IV.

I. *Of the leſſer* European *Iſlands, and firſt of ſuch as lie near* Great Britain.

1. *Thoſe on the* North *are*,

1. THE Orkneys, or Orcades. 2. Shetland.

2. *Thoſe on the* Eaſt *are*,

1. Holy Iſland. 2. Fern Iſland. 3. Cocket Iſland. 4. Shepey Iſland. And 5. The Iſle of Thanet.

3. *Thoſe on the* South *are*,

1. Portland Iſland. 2. The Iſle of Wight. 3. Portſea Iſland.

4. *Thoſe on the* Weſt *are*,

1. Lewis Iſland. 2. Skye. 3. Mull. 4. Jura. 5. Ila. 6. Bute and Arran. 7. Man. 8. Angleſey. And 9. Scilly.

II. *Of other* European *Iſlands, more diſtant from* Great Britain.

1. *The* AZORES.

Theſe iſlands lie W. of England, and are ſubject to the king of Portugal. They are 9 in number; viz. 1. St. Michael. 2. St. Maria. 3. Tercera. 4. Gratioſa. 5. St. George's. 6. Pico. 7. Fyal. 8. Flores. And 9. Cuervo.

2. *Thoſe of* SWEDEN.

Theſe are 7 in number; viz. 1. Rugen. 2. Oeland. 3. Gothland. 4. Oſel. 5. Dago.* 6, Aland. 7. Ween.

3. *Thoſe of* DENMARK.

Theſe are 10; viz. 1. Zealand. 2. Funen. 3. Langland. 4. Laland. 5. Falſter. 6. Mona. 7. Femeren. 8. Alſan. 9. Iceland. And 10. Bornholm.

4. *Thoſe of* NORWAY.

Theſe are 4; viz. 1. Carmen. 2. Hitteren. 3. Sanien. 4. Weroy.

5. MEDITERRANEAN *Iſlands:*

Tyro. How many iſlands go under this name? and how are they ſituate?

Philo. There are a great many iſlands, which are ſituate S. of Europe, in or near the Mediterranean Sea; but the following are moſt noted; viz. 1. Yvica. 2. Minorca. 3. Majorca, ſituate E. of Valencia in Spain. 4. Corſica. 5. Sardinia, lying S. of Genoa. 6. Malta. 7. Sicily, lying S. W. of Naples. 8. Candia. 9. Rhodes. And 10. Cyprus. S. E. of Natolia. The other ſmall iſlands, as I have obſerved, are of little or no conſequence. Thus much for Europe.

Tyro. I heartily thank you, ſir; and now pray give me ſome little idea of the other parts of the world.

Philo. I will, but it muſt be a ſhort hint indeed; though I am willing you ſhould have as much inſtruction as this ſmall tract will allow of. Proceed we then to

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* Oſel and Dago are now ſubject to Ruſſia.

DIALOGUE II.

SECT. I.

Of ASIA.

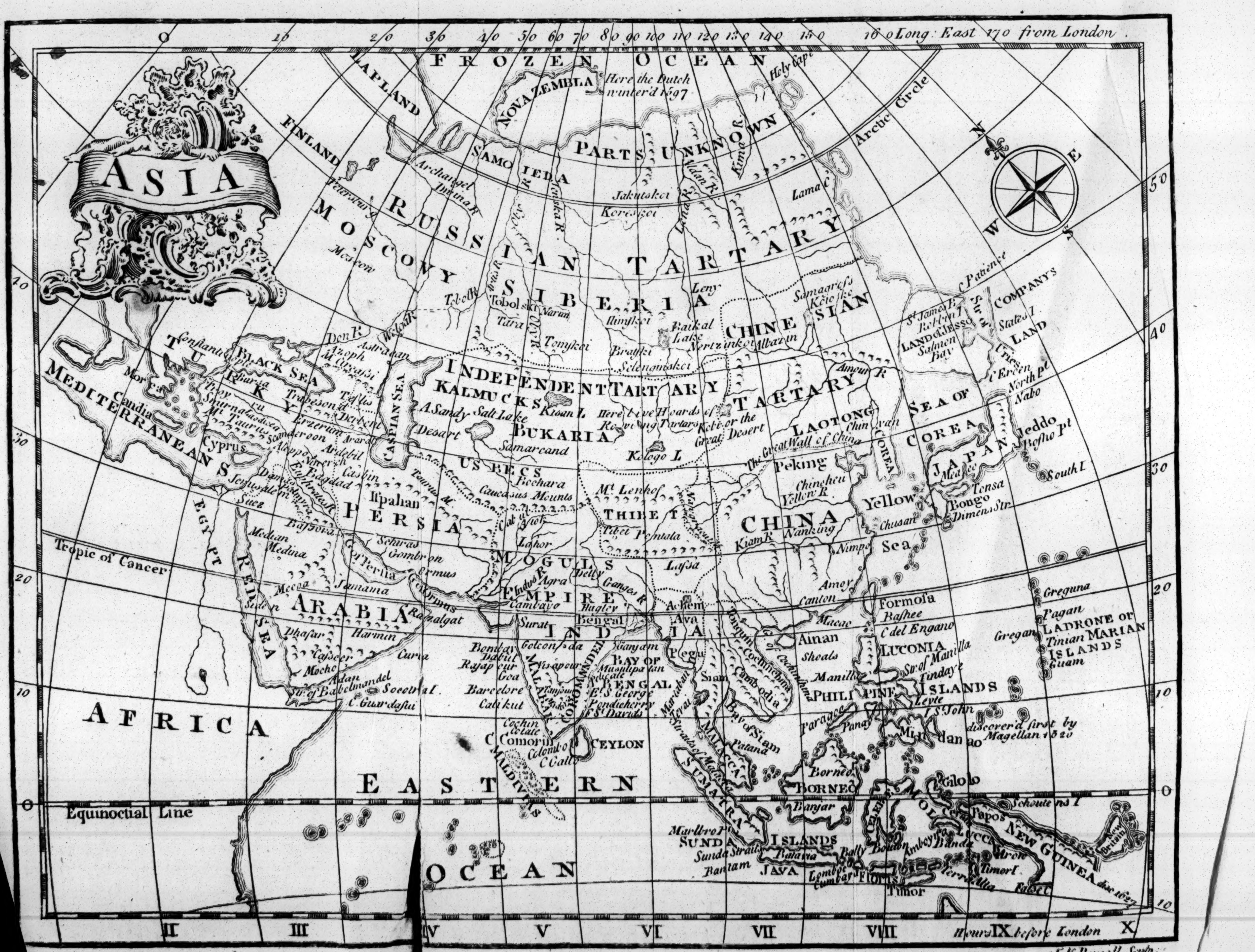
Tyro. IN what part of the globe is Aſia ſituate?

Philo. Aſia, though called the ſecond, yet is the principal quarter of the globe, lying to the E. of Europe. It extends from the Equator to 72 degrees N. latitude, and is divided into 5 principal parts; viz. 1. Tartary. 2. China. 3. India. 4. Perſia. And 5. Turkey. Theſe parts, as well as the chief ſubdiviſions, are accurately laid down in the map of Aſia, which you ſee before you, and which you ſhould often conſult with attention.

1. *Of* TARTARY.

Tyro. How is Tartary ſituate?

Philo. Tartary is bounded on the N. by the Frozen Sea, on the E. by the Pacific Ocean, on the S. by China, India, Perſia, and the Caſpian Sea, and on the W. by Ruſſia. It lies between 35 and 72 degrees N. latitude, and between the 5 and 26 N. climates; is about 3400 miles long, and 2250 broad, and its chief city is Samarcand. The longeſt day in the moſt northern part is about 2 months, and the ſhorteſt



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ſhorteſt in the moſt ſouthern about 9¾ hours. Part of it is ſubject to the neighbouring nations; viz. the Ruſſians, Turks, and Chineſe, and the reſt to the Great Khan of Tartary.

2. *Of* CHINA.

Tyro. How is China ſituate?

Philo. China is bounded on the N. by part of Tartary, on the E. by the Pacific Ocean, on the S. by part of the Indian Ocean, and on the W. by India without the Ganges. It lies between the 3d and 6th N. climates, is about 1400 miles long, and 1260 broad, and its chief city is Pekin, whoſe diſtance from London is 73 degrees; viz. about 5070 miles S. E. From Pekin to Nankin is about 690 miles S. E. in the former of which is a bell, 11 feet diameter, and 12 feet high, weighing 120,000 pounds. The longeſt day in the moſt northern part is about 15 hours; and the ſhorteſt in the moſt ſouthern is about 10¾. It is under the government of its own emperor.

3. *Of* INDIA.

Tyro. How is India ſituate?

Philo. India is bounded on the N. by Tartary, on the E. by China and the Chineſe Sea, on the S. by the Indian Ocean, and on the W. by the ſame Ocean and Perſia. It lies between the Equator and 34 degrees of N. latitude. Its length is about 4000 miles, and its breadth about 2500. It is divided into two grand parts; viz. 1. India within the Ganges, or the Great

Mogul's empire, containing Delhi (his imperial ſeat) Agra, Cambaia, Bengal, the Decan, Golconda, Biſnagar, and Malabar.

2. India without the Ganges, whoſe chief kingdoms are Pegu, Tonquin, Cochinchina, Siam, and Malacca. Length of days and nights, in the northern parts, nearly the ſame as in China.

4. *Of* PERSIA.

Tyro. How is Perſia ſituate?

Philo. Perſia is bounded on the N. by the Caſpian Sea, on the E. by India, on the S. by the Perſian Gulf, and Indian Ocean, and on the W. by Aſiatic Turkey. It lies between 25 and 45 degrees of N. latitude, and between 44 and 70 E. longitude. It reaches from the 3d to the 7th N. climate; therefore muſt of courſe be exceeding hot for many months in the year. Its length is computed at about 1400 miles; its breadth at 1250. It is divided into three parts, N. middle, and S. It is governed by the deſpotic power of the Great Sophy. The people are chiefly Mahometans. The longeſt day in the moſt northern parts is about 15¼ hours, and the ſhorteſt in the moſt ſouthern about 10¼ hours.

5. *Of* TURKEY *in* ASIA.

Tyro. How is Turkey in Aſia ſituate?

Philo. Turkey in Aſia (including Arabia) is bounded on the N. by the Black Sea, on the E. by Perſia, on the S. by part of Africa, and part of the Indian Ocean, on the W. by the Red Sea, the Mediterranean, and the Archipelago. It lies between 12 and 46 degrees of N. latitude; is computed about 2300 miles long, and 2000 broad. It contains ſix great parts; 1. Natolia, whoſe chief city is Burſa. 2. Arabia, whoſe metropolis is Mecca. 3. Syria whoſe capital is Aleppo. 4. Diarbeck, whoſe chief city is Bagdat. 5. Turcomania, whoſe capital is Arzerum. And 6. Georgia, whoſe metropolis is Teflis. This vaſt country is inhabited by Chriſtians, Mahometans, Jews, &c. but is chiefly under the Ottoman yoke.

SECT. II.

Of the Aſiatic *Iſlands.*

Tyro. HOW many iſlands are here, and how are they ſituate?

Philo. There are a great number, but they are chiefly reduced to theſe ſix, whoſe ſituation is as follows; 1. Japan Iſlands, E. of China. 2. The Philippine Iſlands, S. W. of Japan. 3. The Moluccas, S. of the Philippine. 4. The Sunda, W. of the Moluccas. 5. The Banda, or Nutmeg Iſlands. And 6. Ceylon, W. of the Sunda, whoſe capital is Candia, or Candy. And thus much for Aſia.

DIALOGUE III.

SECT. I.

Of AFRICA.

Tyro. HOW is Africa ſituate?

Philo. Africa, the 3d quarter of the world, and ſituate S. on the globe, is almoſt ſurrounded by the Mediterranean Sea, by the Atlantic, Ethiopian, and Indian Oceans, and is extended from 35 degrees of S. latitude, to about 37 N. It is principally divided into 8 Parts; viz. Egypt, Barbary, Biledulgerid, Zaara, called the Deſart, Negro-Land, Guinea, Nubia, and Ethiopia, beſides Iſlands.

1. *Of* EGYPT.

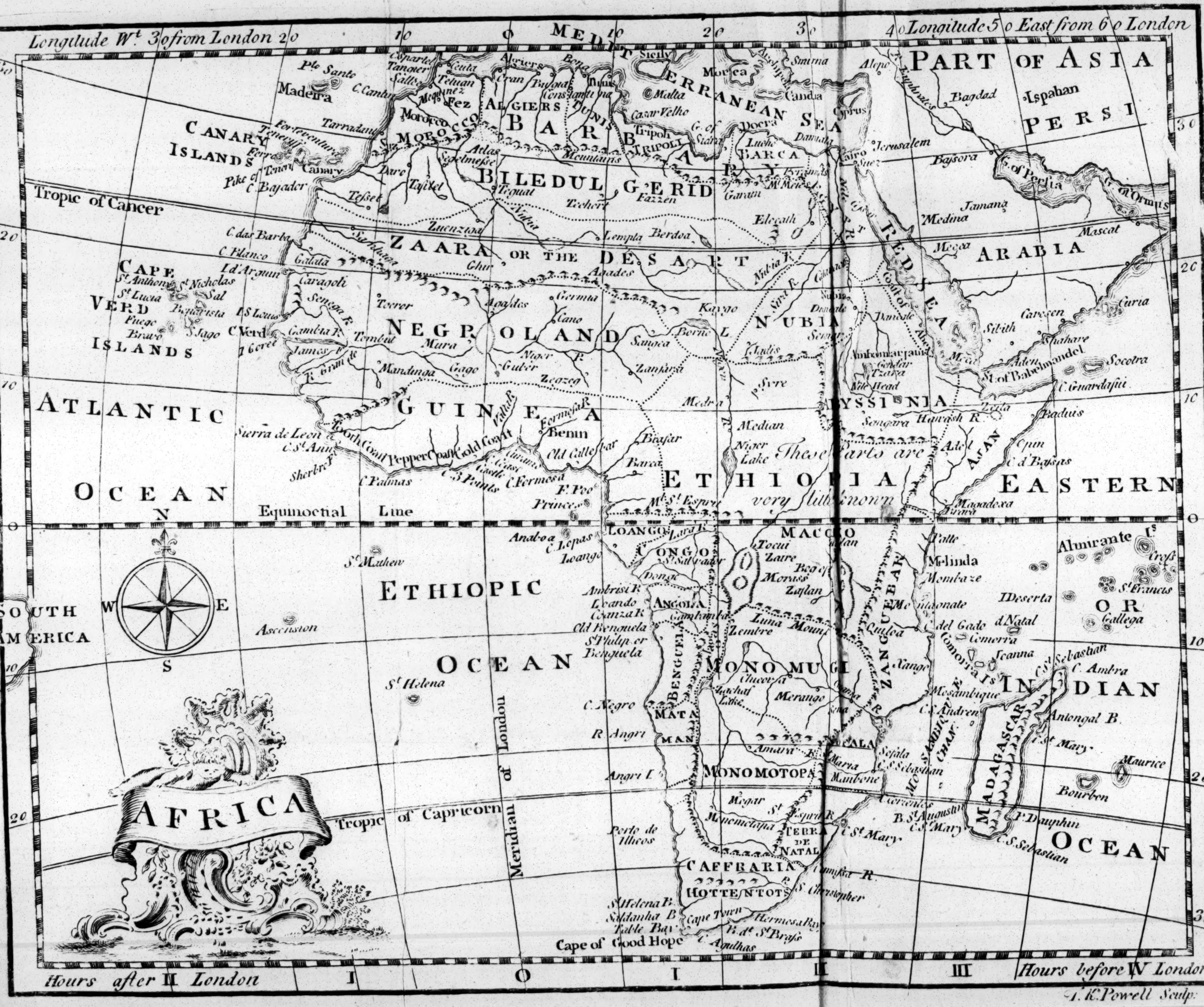
Tyro. How is Egypt ſituate and divided?

Philo. Egypt is bounded on the N. by part of the Mediterranean Sea, on the E. by the iſthmus of Suez and the Red Sea, on the S. by Nubia, on the W. by Barbary and the Deſert. It was formerly called Miſraim. It is divided into lower Egypt, whoſe metropolis is Grand Cairo; and Upper Egypt, whoſe capital is Sayd. It lies between 21 and 31 N. latitude, and the 2d and 4th N. climates, is about 650 miles long, and 150 broad. It is governed by a Baſſa, ſent thither by the Turkiſh emperor: his reſidence is at Grand Cairo.

2. *Of* BARBARY.

Tyro. How is Barbary ſituate?

Philo. Barbary is bounded on the N. by part of



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of the Mediterranean, on the E. by Egypt, on the S. by Biledulgerid, and on the W. by part of the Atlantic Ocean. It extends from 29 to 37 degrees of N. latitude, and lies under the 4th and 5th N. climate. Its length is 2300, and breadth 380 miles.

Barbary is divided into 7 different parts, or ſtates; viz. Morocco, Fez, Telenſin, Algiers, Tunis, Tripoli, and Barca, whoſe chief towns are of the ſame name.

It is chiefly under the government of the Grand Turk, and of the emperor of Morocco, who is called alſo emperor of Africa, king of Morocco, Fez, Sus, and Taſſale; lord of Gago, Dara, and Guinea, and Great Zeriff of Mahomet, and, conſequently, their religion is Mahometiſm. The longeſt day is 14¼ hours, and the ſhorteſt 10½ hours, as in Egypt.

3. *Of* BILEDULGERID.

Tyro. How is Biledulgerid ſituate?

Philo. Biledulgerid is bounded on the N. by Barbary, on the E. by Egypt, on the S. by Zaara, and on the W. by part of the Atlantic Ocean. It lies between 26 and 29 degrees of N. latitude, and under the 3d and 4th N. climate. Its length is about 2050, and breadth 300 miles. The length of days is from 14 hours to 10¼ hours. It is governed by many little kings, but all ſubject to the Great Turk, or to the emperor of Morocco. The whole of Africa I have laid down on a map, in order to give you a true idea of its form, diviſions, and principal places.

4. *Of* ZAARA, *or the* DESART.

Tyro. How is this deſart ſituate?

Philo. Zaara is bounded on the N. by Biledulgerid, on the E. by Egypt and Nubia, on the S. by Negro-Land, and on the W. by the Atlantic Ocean.

It is divided into 7 parts; viz. Borno, Gago, Bardoa, Lempta, Targa, Zuenziga, and Zanhaga, whoſe capital is Targaſſa; the others have the ſame names as their provinces. It lies between 15 and 26 degrees of N. latitude, and under the 3d and 4th climate; is in length 2340 miles, and breadth about 330. The days are from 13¼ long, to 10¾ hours. Their government is by ſeveral lords and kings, called Xeques, and they are chiefly Mahometans.

5. *Of* NEGRO-LAND.

Tyro. How is the land of Negroes ſituate?

Philo. Negro-Land is bounded on the N. by Zaara, on the E. by Nubia, on the S. by Guinea, on the W. by part of the Atlantic Ocean. It lies between 8 and 22 degrees of N. latitude, and under the 2d and 3d N. climate. It is computed to be about 2280 miles long, and 600 broad. It is divided into 13 provinces; viz. Genohoa, Gelata, Tombut, Agades, Carro, Gaſſena, Guangara, Melli, Mandinga, Gaga, Guber, Zegzeg, and Zanfara, whoſe capitals are of the ſame name. The days are very little different in length from thoſe in Zaara. It is governed by ſeveral kings, but all, or moſt, are ſubject to the king of Tombut. Groſs idolatry and Mahometiſm prevail here.

6. *Of* GUINEA.

Tyro. How is this country ſituate?

Philo. Guinea is bounded on the N. by Negro-Land, on the E. by Ethiopia Exterior, on the S. by the Ethiopean Ocean, and on the W. by the Atlantic Ocean. It is divided into 4 parts; 1. The coaſt of Maleguette, whoſe capital is Timan. 2. The Ivory Coaſt weſtward, whoſe metropolis is Toba. 3. The Golden Coaſt eaſtward, whoſe capital is St. George de Mina. And 4. The kingdom of Benin, metropolis Arda. Guinea lies between 5 and 13 degrees of N latitude. Its length is 1320, and breadth about 400 miles. It is ſubject to the emperor of Guinea, and Paganiſm is here the prevailing ſuperſtition. Their days are from 12¼ hours to 11¾ hours.

7. *Of* NUBIA.

Tyro. How is Nubia ſituate?

Philo. Nubia is bounded on the N. by Egypt, on the E. by Ethiopia Exterior, on the S. by Ethiopia Interior, on the W. by part of Zaara and Negro-Land. It lies between 14 and 22 degrees of N. latitude, and under the 2d and

3d N. climate. Its length is about 840, and breadth about 570 miles. The river Nile runs through it, and the principal towns known to the Europeans are Sinnar, and Dangola.

It is governed by its own independent prince. Their traffic is chiefly to Grand Cairo. The length of the days is much the ſame as in Zaara.

8. *Of* ETHIOPIA INTERIOR.

Tyro. How is this country ſituate?

Philo. Ethiopia Interior, called alſo the land of the Abyſſinians, is bounded on the N. by Nubia, and on the E. S. and part of the W. by Ethiopia Exterior. It lies under the 1ſt, 2d, and 3d N. and S. climates; and the length is computed at 3600 miles, and breadth about 2200. Ethiopia Interior is divided into 8 provinces: viz. 1. Barnagaſſo. 2. Tigremahon. 3. Dobaſſat. 4. Fatigar. 5. Angote. 6. Amara. 7. Beleguanze. And 8. Begramedri. It is governed by its own independent prince, lord, or ruler, called Naggaſi, whoſe government is deſpotic. He ſtiles himſelf the beloved of God, (ſays he ſprung from the ſtock of Judah) the ſon of the column of Sion, the ſon of the ſeed of Jacob, the ſon of the hand of Mary, the ſon of Nahu after the fleſh, and of St. Peter and Paul after the ſpirit, &c. &c. The longeſt day in the moſt northern parts of this country is about 13½ hours, and the ſhorteſt in the moſt ſouthern 10½ hours.

EXTERIOR.

Ethiopia Exterior is bounded on the N. by Abyſſinia, on the E. W. and S. by the Ethiopic and Indian Oceans; and, if to this you add the land of the Hottentots, it extends to near 35 degrees S. latitude. It comprehends the kingdoms of Biafara, Loango, Congo, and Angola; the empires of Monomugi and Monomotopa; and the coaſts of the Cafres, Zanguebar, Anian, and Abex. It is governed by various princes, and the people are chiefly groſs idolaters and Mahometans. As for the Hottentots, they ſhew no ſign of any devotion, only are very ſuperſtitious.

The days are from 12 to 14 hours.

SECT. II.

Of the AFRICAN *Iſlands.*

Tyro. WHAT are the principal Iſlands in Africa?

Philo. There are many ſmall iſlands, but the moſt noted are the following; viz. 1. The iſland of Madagaſcar. 2. Cape Verde Iſlands. 3. The Canary. And, 4. the Madeira Iſlands.

1. MADAGASCAR.

This is a large iſland, lying S. E. of Ethiopia, and extends from 10 to about 25 degrees of S. latitude; is about 1000 miles long, and 300 broad. It is called by the Portugueze St. Laurence,

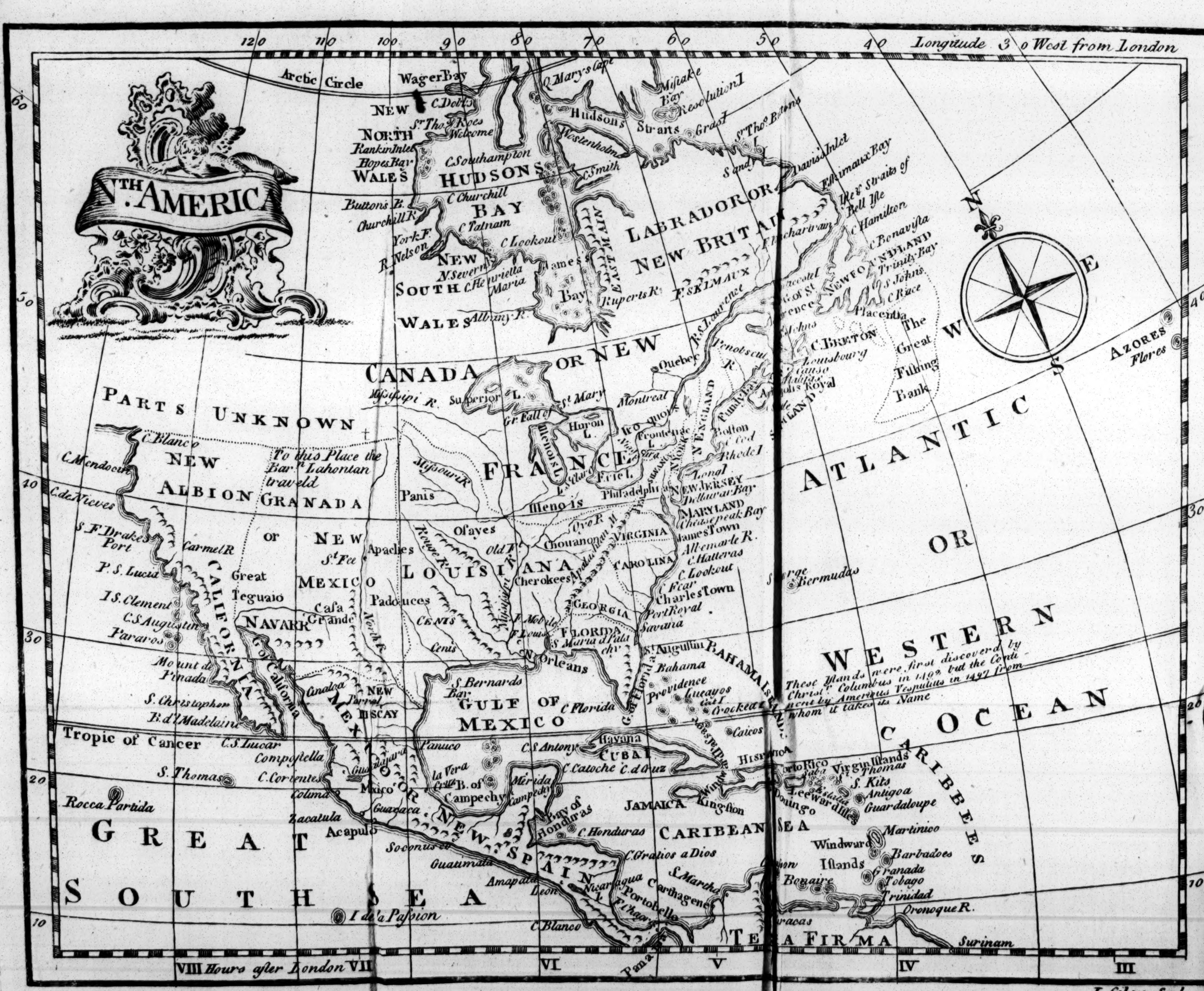
rence, becauſe they firſt diſcovered it on that day. The inhabitants (except in the eaſtern part) are chiefly Pagans and Mahometans; and are ſo governed by their prieſts (called Ombiaſſes) that they are extremely ſuperſtitious. Thus, if a child be born upon ſuch a day, they ſay it is unlucky, and therefore give it to the wild beaſts; and, if a woman dies in child bed, they bury the living child with her, becauſe it is better ſo (they ſay) than to live without a mother to take care of it. And thus, by theſe cruel and abſurd practices, their iſland is very thin of inhabitants. It is under no particular governor.

Cape VERDE *iſlands.*

Theſe lie S. W. of Barbary, and N. W. of Guinea, between 13 and 17 degrees N. latitude, and are as follow: 1. St. Anthony. 2. St. Vincent. 3. St. Lucia. 4. St. Nicholas. 5. Inſula de Sal. 6. Bonaviſta. 7. Mago. 8. St. Jago. 9. Inſula del Fuego. 10. Bravo. The chief town is St. Domingo. They are ſubject to Portugal.

3. *The* CANARY *iſlands.*

Theſe lie N. of the Cape Verde iſlands, and between 27 and 29 degrees N. latitude. They are 7 in number; viz. 1. Lancerota. 2. Forte Ventura. 3. Canaria. 4. Teneriffe, famous for its peak. 5. Gomera. 6. Ferro, where formerly the firſt meridian was fixed by common conſent; but now every nation fixes it at its own metropolis. And, 7. Palma. They are ſubject to the king of Spain.



J. Gibson Sculp:

4. MADEIRA, *or* MADEIRAS.

This lies in about 32 degrees N. latitude, and W. of Morocco. Its chief town is Funchal. It is ſubject to the Portugueze.

Tyro. Are theſe all the iſlands?

Philo. There are ſome of leſs note; viz. 1. Zocotora, ſubject to the Arabians. 2. Comora, N. W. of Madagaſcar. 3. St. Thomas. 4. Prince's Iſland. And, 5. Annabona, ſubject to the Portugueze, lying W. of Ethiopia. 6. St. Helena, ſubject to the Engliſh, lying S. W. of St. Thomas's. And, 7. The Iſle of Aſcenſion, N. W. of St. Helena. Thus much for Africa.

Tyro. I return you thanks, Sir.

Philo. Now, *Tyro,* for the laſt quarter of the world; viz. America.

DIALOGUE IV.

SECT. I.

Of AMERICA.

Tyro. WHAT is this quarter called, and how is it ſituate?

Philo. America, called the 4th or laſt quarter of the world, and weſtward on the globe.

It is divided into 2 principal parts; one called North, and the other South America. And accordingly I have drawn two maps, one of the former, and the other of the latter;

which will give you adequate ideas of this extenſive quarter of the globe.

I. *Of* NORTH AMERICA.

Tyro. Why is this called North America?

Philo. Becauſe it lies on the N. ſide of the equator.

Tyro. Into how many principal parts is it divided?

Philo. Into 5, as follows; viz. 1. Mexico, or New Spain. 2. New Mexico, called Grenada. 3. Florida. 4. Terra Canadenſis. And 5. Terra Arctica.

1. *Of* MEXICO, *or* NEW SPAIN.

Tyro. How is this country ſituate?

Philo. Mexico, diſcovered in 1518, and conquered by the Spaniards in 1521, is bounded on the N. by Nova Granada, on the E. by the gulph of Mexico, on the W. by the Pacific Ocean, and on the S. by Terra Firma. It lies chiefly in the torrid zone, between 8 and 30 degrees of N. latitude, and is extended to about 33 degrees of longitude. The greateſt length is computed to be 2000, and breadth about 600 miles.

Tyro. Into how many principal parts is this country divided?

Philo. Into 3, called Audiences; viz. 1. Guadalajara. 2. Mexico. And 3. Guatimala. The capitals are of the ſame names as the Audiences.

1. GUADALAJARA.

This contains the provinces of Cinaloa, New Biſcay, Zacaticas, Gaudalajara, Chiameltan, and Zaliſco.

2. Mexico contains the provinces of Panuco, Mexico, Mechoachan, Loſs Angelos, Anlequera, Tabaſco, and Jucatan.

3. Guatimala comprehends Soco Nuſco, Guatimala, Nicaragua, Coſta Rica, Veragua, Honduras, Verapaz, and Chiapa. The longeſt day in the moſt northern part of this country is about 13½ hours, and in the moſt ſouthern about 12½ hours. It is governed by the king of Spain, under a viceroy, who reſides at Mexico. The Indians are in general Idolaters; but the Spaniards, here, as in Europe, are all of the Catholic religion.

2. *Of* NEW MEXICO, *called* NOVA GRANADA.

Tyro. How is this part of N. America ſituate.

Philo. This country was diſcovered by the Spaniards, in 1540, and is bounded on the N. by Terra Arctica, on the E. by Florida, on the S. by Mexico, or New Spain, and on the W. by California. Its extent is not yet known. The chief town is Santa Feé, the reſidence of the Spaniſh governor.

3. *Of* FLORIDA.

Tyro. How is this country ſituate?

Philo. Florida, diſcovered alſo by the Spaniards, 1497, and poſſeſſed by them in 1527, is bounded on the North by Georgia, on the E. by the Atlantic Ocean, on the S. by the Gulf of Mexico, and on the W. by the river Miſſiſſippi. It lies between 25 and 32 degrees of N. latitude, and under the 5th and 6th N. climate, comprehends 23 degrees of longitude, and is computed to be about 500 miles long, and 440 broad, in its greateſt extent.

The natives are groſs idolaters. The interior parts are independent: but the places upon or near the ſea coaſts lately belonged to the Engliſh, but, by the treaty of peace in 1783, were ceded to Spain. The longeſt day in the moſt northern part is about 14¼ hours, and the ſhorteſt in the moſt ſouthern about 10½ hours.

The chief towns are St. Auguſtine and Penſacola.

4. *Of* TERRA CANADENSIS.

Tyro. How is this country ſituate?

Philo. It is bounded on the N. by part of Terra Arctica, on the E. by the Atlantic Ocean, on the S. by the Gulf of Mexico, and on the W. by New Mexico and parts unknown. It lies between 30 and 62 degrees of N. latitude, and extends to near 40 degees of longitude; is about 2100 miles in length, and 1600 in breadth.

Tyro. But pray is it not divided into ſome principal parts?

Philo. Yes, into N. and S. The N. comprehends, 1. Terra Canadenſis Propria. 2. Nova Britannia, or New Britain. 3. Nova Francia, New France, or Canada; chief town Quebec. This laſt now belongs to Great Britain.

Tyro. What does the S. part contain?

Philo. 1. Nova Scotia. 2. New England. 3. New York. 4. The Jerſeys. 5. Penſilvania. 6. Maryland. 7 Virginia. 8. Carolina. And 9. Georgia. All theſe (Nova Scotia excepted) containing in the whole, 13 provinces, have lately renounced their allegiance to the crown of Great Britain, and, at the concluſion of the laſt war in 1783, were acknowledged, by the Engliſh and by the reſt of the world, as ſovereign and independent States.

The chief towns of theſe provinces in order are, 1. Halifax in Nova Scotia. 2. Boſton. 3 New York. 4. Elizabeth. 5. Philadelphia. 6. Annapolis Royal. 7. James Town. 8. Charles Town. And 9. Savannah.

1. Nova Scotia, diſcovered in 1622.

2. New England, in 1497, and poſſeſſed for queen Elizabeth, by Sir Philip Amadas, in 1558.

3. New York, by Mr. Hudſon, in 1608, and ſold to the Dutch, who kept it till 1664; at laſt it was given by Charles II. to the duke of York; it was called before New Netherland.

4. New Jerſey, was diſcovered in 1497.

5. Penſilvania about the ſame time. It was given by Charles II. to William Penn, Eſq. by letters patent in 1680.

6. Virginia, in 1497, but more particularly in 1585, by Sir Walter Raleigh, who is ſaid to be the firſt that brought tobacco into England. It was called Virginia, in honour of queen Elizabeth, as a virgin queen.

7. Maryland, was alſo diſcovered by the Engliſh under the two Cabots, in 1497. It has its name from Mary, wife of Charles I. who gave it by letters patent to the right honourable Cæcilius Calvert, Lord Baltimore, in 1632.

8. Carolina, diſcovered about the ſame time, and in 1660 granted by patent to ſeveral noblemen, by Charles II.

5. *Of* TERRA ARCTICA.

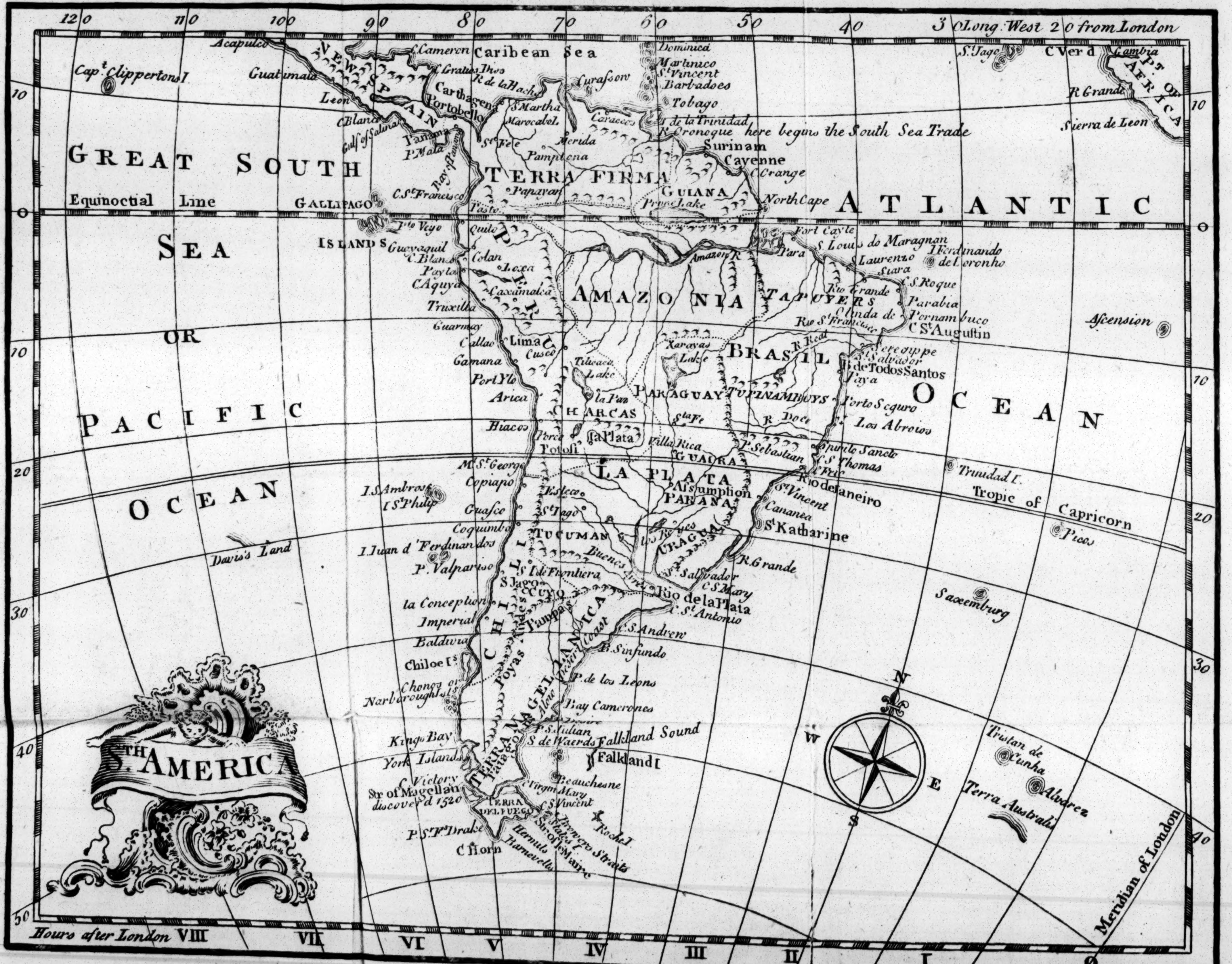
Tyro. What do you mean by Terra Arctica?

Philo. This country is called Arctica, becauſe it lies towards the North; it comprehends thoſe parts of America, or lands near America, ſituate near, or towards, the N. pole, or polar circle.

Tyro Which are they?

Philo. There are many of them; but the chief and moſt noted are, 1. Greenland. 2. Spitſbergen. 3. Nova Zembla. 4. Terra de Jeſſo. 5. New Denmark. And, 6. New North Wales.

Little more is known of theſe at preſent but their names and therefore they cannot be taken any further notice of.



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II. *Of* SOUTH AMERICA.

Tyro. Why is this ſo called?

Philo. Becauſe it lies chiefly on the S. ſide of the equator.

Tyro. Into how many principal parts is it divided?

Philo. Into 7; viz. 1. Terra Firma. 2. Peru. 3. The Land of the Amazons. 4. Braſil. 5. Chili. 6. Paraguay. And, 7. Terra Magellanica.

1. *Of* TERRA FIRMA.

Tyro. How is this ſituate?

Philo. Terra Firma, diſcovered in 1514, lies under the 1ſt N. climate, and is bounded on the N. by the Atlantic Ocean, on the E. by the ſame, on the S. by Peru and the country of the Amazons, and on the W. by the Pacific Ocean. It is extended to about 27½ degrees of longitude, and lies between the equator and 11½ degrees of N. latitude. It is computed to be about 1500 miles long, and 750 miles broad.

Tyro. How is it divided?

Philo. Into E. and W. The E. upon the river Oroonoque, called Guiana, whoſe chief towns are Surinam and Cayenne. The W. comprehends the provinces of

1. Panama, called alſo Terra Firma; chief town is Panama.
2. Carthagena, metropolis the ſame.
3. St. Martha, metropolis the ſame.
4. Rio de la Hacha, metropolis the ſame.

5. Andaluzia, metropolis St. Thomas.

6. Comana, metropolis Comana.

7. New Granada, metropolis St. Fée de Bagota.

8. Papayan, metropolis Papayan.

It is governed, for the king of Spain, by a viceroy reſiding at Mexico. The natives of this country, eſpecially in the middle, are groſs idolaters.

2. *Of* PERU.

Tyro. How is this country ſituate?

Philo. Peru, firſt diſcovered by the Spaniards, in 1525, is bounded on the N. by part of Terra Firma, on the E. by Amazonia, on the S. by Chili, and on the W. by the Pacific Ocean. It lies between 24 degrees of S. and 1 degree of N. latitude, and is extended to 20 degrees of longitude, and under the 1ſt, 2d, and 3d S. climate.

Tyro. How is it divided?

Philo. Into three provinces.

1. Quito, N. whoſe chief towns are Quito and Payta.

2. Lima, or Los Reyes, in the middle, whoſe chief towns are Lima, the metropolis, Cuſco, and Callao.

3. Los Charcos, whoſe chief towns are Portoſi and Porco.

The natives in general are very groſs idolaters, worſhipping the ſun, moon, ſtars, thunder, lightning, &c. But in ſome parts there are Chriſtians, &c.

It was conquered by the Spaniards in 1533, and they have the moſt conſiderable part of it under their dominion.

3. *Of the Land of the* AMAZONS.

Tyro. How is this land ſituate?

Philo. This country, diſcovered by the Spaniards in 1541, is bounded on the N. by Terra Firma, on the E. by Braſil, on the S. by Paraguay, and on the W. by Peru.

It lies under the 1ſt, 2d, and 3d S. climate. It is under no particular government, the inhabitants in general being a ſavage ſort of people, appearing always in arms. From this circumſtance it is ſuppoſed to take its name, in alluſion to thoſe ancient warlike women the Amazons, who are ſpoken of by the poets, and by ſeveral hiſtorians.

4. *Of* BRAZIL.

Tyro. How is Brazil ſituate?

Philo. This country, diſcovered by the Portugueze, about 1501, is bounded on the N. and E. by the Atlantic Ocean, on the S. by the mouth of the river Plata, and on the W. by a chain of mountains, which divides it from Paraguay, and the country of the Amazons.

It lies between the equator and 35 degrees of S. latitude, and under the 1ſt, 2d, 3d, 4th, and 5th S. climate.

Its greateſt length is computed to be about 2500 miles, and its breadth about 700.

Tyro. Into how many principal parts is it divided?

Philo. There is not any particular account of its provinces, diviſions, &c. but the chief towns that are known, or moſt worthy of note, are as follow: 1. St. Vincent. 2. Sanctos. 3. Angra Dos Reyes. 4. St. Sebaſtian, or Rio de Janeiro. 5. Spiritu Sancto. 6. Porto Seguro. 7. St. Salvadore. 8. Pernambuco. And 9. Parayba.

The natives are under no particular government, nor profeſs any religion, being chiefly ſunk into groſs ignorance, idolatry, &c.

5. *Of* CHILI.

Tyro. How is this country ſituate?

Philo. Chili, diſcovered by the Spaniards about 1554, is bounded on the N. by Peru, on the E. by Paraguay, on the S. by Terro Magellanica, and on the W. by the Pacific Ocean.

It lies between 25 and 44 degrees of S. latitude, and under the 4th, 5th, and 6th S. climates.

Its length is computed to be about 1100 miles, and its breadth 600.

Tyro. Into how many parts is Chili principally divided?

Philo. Into 3; viz. 1. Chili Proper. 2. Chili Imperial. And, 3. Chucuito, whoſe chief towns are St. Jago, Baldivia, and St. John de Fontieta.

It is chiefly governed by the viceroy of Peru, under the king of Spain.

6. *Of* PARAGUAY.

Tyro. How is Paraguay ſituate?

Philo. This country, diſcovered alſo by the

Spaniards in 1546, is bounded on the N. by the land of the Amazons, on the E. by Brazil, on the S. by Terra Magellanica, and on the W. by Chili and Peru.

Tyro. Whence has it its name?

Philo. From the river Paraguay; but it is called by the Spaniards (and currently by others) Rio de la Plata.

It lies between 12 and 37 degrees of S. latitude, and under the 2d, 3d, 4th, and 5th S. climate, and extends to about 25 degrees of longitude.

Its length is computed about 1500 miles, and breadth about 1100 miles.

Tyro. Into how many principal parts is it divided?

Philo. The moſt material provinces are 5 in number; viz. 1. Guayra, whoſe chief town is Cividad Real. 2. Paraguay Proper, whoſe chief town is Aſſumption. 3. Chaco, whoſe chief town is Conception. 4. Tucoman, whoſe chief town is St. Jago. And, 5. Rio de la Plata, whoſe chief town is Buenos Ayres. It is governed chiefly by a viceroy.

Of TERRA MAGELLANICA.

Tyro. How is this country ſituate?

Philo. It is bounded on the N. by part of Paraguay and Chili, on the E. by the Atlantic Ocean, on the S. by the Straits of Magellan, and on the W. by the Pacific Ocean.

It was diſcovered about 1519, by one Ferdinand Magellan, from whom it took its name.

SECT. II.

Of the AMERICAN *Iſlands, and* NEW DISCOVERIES.

Tyro. WHAT are the principal iſlands of America?

Philo. They are 11, which are thus divided:

1. In the North	1. Newfoundland	
	2. California*	
2. In the Middle	3. Cuba	Called the Great Antiles.
	4. Jamaica	
	5. Hiſpaniola	
	6. Porto Rico	
	7. Bermudas	
	8. Lucayos, or Bahamas	
	9. Caribbees	
	10. Sotovento	Called the Little Antiles.
3. In the South,	11. Terra del Fuego	

1. *Of* NEWFOUNDLAND.

This iſland was diſcovered by the two Cabots, in the time of Henry VII. 1497; but more perfectly by Thorn and Elcot of Briſtol, in 1527. It lies between 46 and 52 degrees of N. latitude, near New-Britain.

It is ſubject to the crown of England. It is chiefly valuable on account of the great cod-fiſhery upon its banks, which is ſuppoſed to employ upwards of 10,000 hands, and to increaſe the national wealth about 300,000l. a year. Chief towns Placentia, Bonaviſta, and St. John's.

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* Now known to be a peninſula.

2. *Of* CALIFORNIA.

The northern part of this peninſula was diſcovered by Sir Francis Drake in 1577. It has Mexico on the E. and the Pacific Ocean on the W. It lies between 23 and 43 degrees N. latitude.

3. *Of* CUBA.

This iſland was diſcovered by the Spaniards in 1594. It lies N. of Jamaica, N. W. of Hiſpaniola, and S. of the Bahama iſlands. It lies between 19 and 23 degrees N. latitude, and extends to about 13 degrees of longitude. It is ſubject to the king of Spain, and the chief towns are the Havannah and St. Jago.

4. *Of* JAMAICA.

This was diſcovered by Columbus, and conquered from the Spaniards by Penn and Venables in Oliver Cromwell's time. It was firſt called St. Jago, but afterwards Jamaica, in honour of James duke of York.

It lies S. of Cuba, and W. of Hiſpaniola, and between 17 and 19 degrees N. latitude, and extends to about 3 degrees of longitude.

It is ſubject to the Engliſh. Its chief towns are Kingſton, Port Royal, and Spaniſh Town.

5. *Of* HISPANIOLA.

This was diſcovered alſo by Columbus in 1492. It lies between 17 and 21 degrees of N. latitude. It has Cuba on the N. W. Jamaica on the W. and Porto Rico on the E. The weſtern part was ſubject to France, the eaſtern to Spain. Its principal town is St. Domingo. The whole iſland was ceeded by Spain to France by treaty concluded in 1795.

6. *Of* PORTO RICO.

Porto Rico (once called Johannis Inſula, and by the natives Bonquin) lies E. of Hiſpaniola, in about 18 degrees N. latitude. It is called Porto Rico from the city and haven of the ſame name. It is ſubject to Spain.

7. BERMUDAS.

Bermudas, ſo called from John Bermudas, a Spaniard, who firſt diſcovered it. It lies between 32 and 33 degrees of N. latitude, about 240 Engliſh leagues E. of Carolina; and is ſubject to the crown of Great Britain.

8. *Of the* LUCAYOS.

Tyro. Why are theſe ſo called?

Philo. From Lucayos, the longeſt of them all. They extend from the coaſt of Florida, to the N. of Hiſpaniola.

The chief of them are, 1. Bahama. 2. Lucayos. 3. Providence. 4. Cignatio. 5. Guanahani. 6. Tuma. 7. Tama. 8. Samana. And 9. Maiaguana.

The principal of theſe is Bahama, near Cape Florida, and remarkable for ſpiders, they being about 2 inches long, and having, in general, 6 eyes.

9. *Of the* CARIBBEE *Iſlands.*

Tyro. Why are theſe iſlands ſo called?

Philo. From the inhabitants, who, upon the firſt diſcovery, were found to be cannibals. They repreſent the ſegment of a circle, are about 30 in number, and extend from about 17 degrees N. almoſt to Terra Firma.

The chief among them are 1. Anguila. 2. St. Martin. 3. Sancta Crux. 4. Barbuda. 5. St. Chriſtopher's. 6. Nevis, or Mevis. 7. Antego. 8. Montſerat. 9. Guadalupe. 10. Marigalant. 11. Dominica. 12. Martinico. 13. St. Lucia. 14. Barbadoes. 15. St. Vincent. 16. Granada. And, 17. Tobago.

Note, Some of theſe belong to the Engliſh, ſome to the French, and others to the Dutch. One of the moſt conſiderable of them is Barbadoes, in about 13½ degrees N. latitude. It is ſubject to the Engliſh. Metropolis Bridge Town.

10. *Of the* SOTOVENTO.

Theſe are ſo called by the Spaniards, to whom they chiefly belong, and are found from E. to W. along the coaſt of Terra Firma. The principal of them are, 1. Trinidada. 2. Margarita. 3. Tortuga. 4. Orchilla. 5. Rocca. 6. Bonayre. 7. Curacoa. And 8. Aruba.

11. *Of* TERRA DEL FUEGO.

This (according to ſeveral hiſtorians) is ſo called, on account of ſeveral volcanos. It is ſituate S. of Magellanica, and parted from the continent by the Straits of Magellan, lying between 52 and 56 degrees S. latitude.

NEW DISCOVERIES.

Of late years ſeveral voyage have been performed round the world, particularly by the celebrated Captain Cooke; and, in the courſe of theſe, ſome new iſlands have been diſcovered, and the coaſts of others more perfectly explored. The principal of thoſe newly diſcovered are, Otaheite, the Society Iſlands, Oheteroa, the Friendly Iſlands, the New Hebrides, New Caledonia, the Marqueſas, the Pelew Iſlands, and the Sandwich Iſlands; at one of the latter, called Owhyhee, Captain Cooke was unfortunately killed, Feb. 14, 1779.

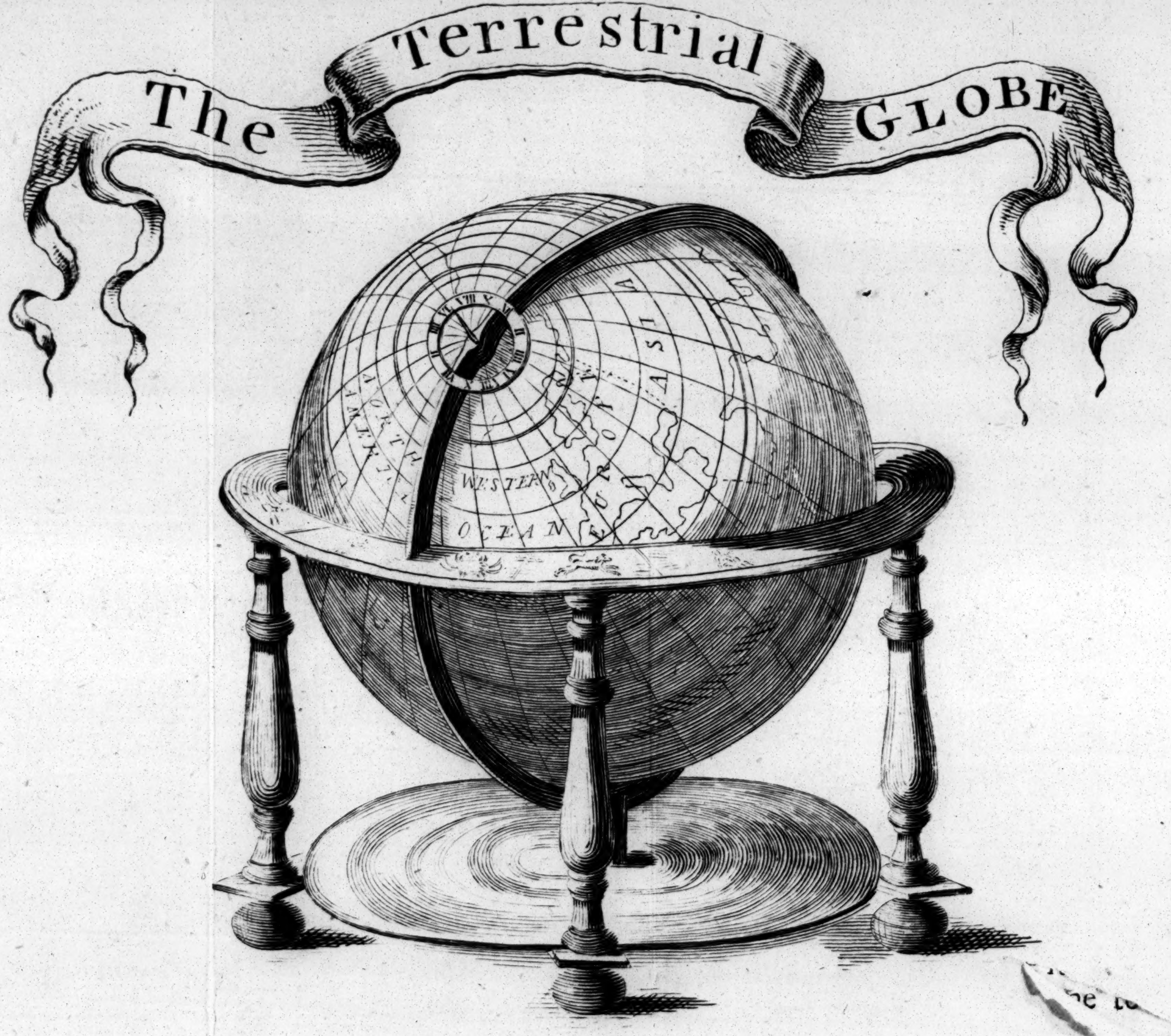
Thoſe more perfectly explored are, New Guinea, New Zealand, and New Holland. The latter is, by much, the largeſt iſland in the world; on the eaſt coaſt of which, called New South Wales, is Botany Bay, the place to which the convicts are now tranſported. Diſtant from London 10,500 miles, S. E.

The firſt convicts deſtined for Botany Bay (being 750 in number) ſailed from Portſmouth on Sunday the 13th of May, 1787, and arrived at Botany Bay in January, 1788.

Thus, *Tyro*, I have given you as complete a view of Geography as I could in ſo narrow a compaſs; and I hope it will be ſufficient to excite the curioſity of young beginners, and to qualify them in time for underſtanding thoſe authors that have treated more largely and particularly on the ſubject.

And now, *Tyro*, we are come to the uſe of the Globes.

BIBLIOTHECA BODLEIANA

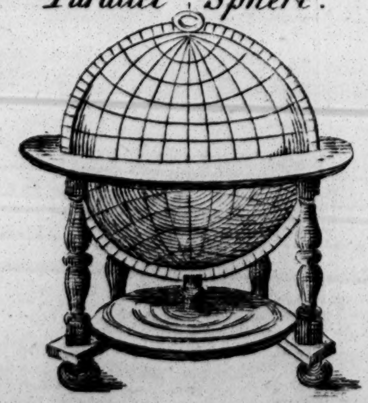


E'er half the SCHOOL *Authors be Read, it will be seasonable for* YOUTH *to lea*
the Use of the GLOBES.

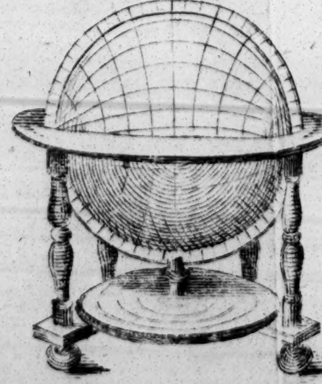
MILTON *on* Education.

The GLOBE *or Sphere in its Three Different* Positions.

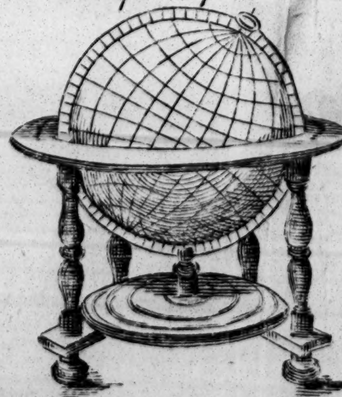
Parallel Sphere.



Direct Sphere.



Oblique Sphere.



T.K.Powell Sculp.

DIALOGUE V.

Between PHILO, *a Tutor, and* TYRO, *his Pupil, concerning the nature, properties, and uſe of the* GLOBES.

SECT. I.

Tyro. WHAT is a globe, or ſphere?

Philo. A globe, or ſphere, is a ſolid round body, contained under one ſurface; having a point in the middle, called the centre, from whence all lines drawn to the ſurface are equal.

Tyro. Pray, how is a globe generated or formed?

Philo. It is made by the rotation of a circle, or ſemi-circle, broad ways upon its axis: thus, a ſhilling preſſed upon its edge, by two pins oppoſite each other, and blown round, will naturally repreſent the formation, or ſhape of a globe.

Tyro. How many ſorts are there?

Philo. Two, one called the Terreſtrial, or earthly: the other the Celeſtial, or heavenly globe.

Tyro. What does the Terreſtrial globe teach us?

Philo. By the Terreſtrial globe we are taught he knowledge of the earth and ſea; with the ituation of places, their difference in latitude nd longitude; the ſun's riſing and ſetting; the ength of days and nights throughout the year, and the true diſtance from one place to another. This is called Geography.

Tyro. What is the uſe of the Celeſtial globe?

Philo. The Celeſtial globe not only teaches us the ſun's riſing and ſetting, but alſo the riſing and ſetting of the ſtars, together with their right Aſcenſion, Declination, Amplitude, Almacanther, Azimuth, Latitude, Longitude, and Diſtance from each other. This is called Aſtronomy.

Tyro. But I muſt know firſt what Almacanther, Azimuth, &c. mean.

Philo. That you ſhall know by and by: but firſt you muſt learn the names of the appendants and different circles belonging to the globe.

Tyro. Pleaſe then to let me know what they are.

Philo. I will; and only take a little pains to learn the nature of them, and you will ſoon be qualified to work ſome problems yourſelf.

SECT. II.

A further deſcription of the GLOBES, *with the great circles and appendants belonging to them.*

Tyro. WHAT do you mean by great circles of the ſphere?

Philo. Great circles are ſuch as cut the globe into two equal parts, paſſing through the centre: all ſuch as do not cut the ſphere into two equal parts, are called leſſer circles.

Tyro. Pray how many great circles are there?

Philo. 1. The Equator, or Equinoctial. 2. The Ecliptic, or Zodiac. 3. The Brazen Meridian. 4. The Horizon. And 5. The Colures.

1. *Of the* EQUATOR.

Tyro. What is the Equator, or Equinoctial?

Philo. The Equator on the Terreſtrial, or Equinoctial on the Celeſtial Globe, is a line, or circle, that cuts the Globe into two equal parts, called northern and ſouthern hemiſpheres, whoſe poles are thoſe of the world, dividing the N. from the S. and upon the Globe it is eaſily known by two broad lines running parallel to each other, and a fine hair line between them: it is divided into 360 equal parts, called degrees, beginning, on the Celeſtial Globe, at the firſt meridian (or ſign Aries) and is marked from 1 with 10, 20, 30, 40, &c. to 360, quite round. The firſt meridian on the Terreſtrial Globe, as I have already obſerved, was formerly fixed at the iſland of Ferro; but now almoſt every nation fixes it at its own metropolis.

Tyro. But there are other figures on the lower edge, or part, of the Equator on the Terreſtrial Globe; are there not?

Philo. Not on all Globes. Senex's Globes, indeed (which, as I ſaid before, I would recommend) are alſo marked from the meridian of London, with 10, 20, 30, &c. to 180 degrees to the right-hand, or E. and, in like manner, towards the leſt-hand from London, with 10, 20, 30, &c. to 180, W.

Tyro. And, pray, what is the uſe of this?

Philo The Equator ſhews you the longitude of any place, either E. or W. from the firſt meridian; and this lower line on Senex's Globe ſhews you the longitude of any place from London, which is extremely convenient. The upper line of figures on the Equinoctial ſhews the right and oblique aſcenſion of the ſun, or any ſtar.

2. *Of the* ECLIPTIC *and* ZODIAC.

Tyro. What, or which is the Ecliptic?

Philo. The Ecliptic is another great circle of the ſphere, whoſe poles are in the polar circles, where it is interſected by the *ſolſtitial Colure*, running from Cancer ſouth, and from Capricorn northward. It cuts the Equator at the two points Aries and Libra, making an angle at each point of 23 degrees, 30 minutes, which is its furtheſt, or utmoſt extent, either N. or S. from the Equator, as you will ſee more plainly hereafter.

Tyro. What is the Zodiac?

Philo. The Zodiac is a broad imaginary circle, which extends itſelf (according to the rules of Aſtronomy) eight degrees on each ſide of the Ecliptic, and is that which contains the 12 ſigns, and in which the planets perform their revolutions. The line in the middle of the Zodiac is called the Ecliptic; becauſe Eclipſes happen in or near that line. It is called Via Solis, the Sun's path, or way. ☞ But in Aſtronomy, it is that circle, or path, which the earth would deſcribe to an eye, placed in the centre of the ſyſtem, viz. the ſun.

Tyro. Pray, Sir, tell me in what manner the Ecliptic is divided, for I think, I have ſome notion of it.

Philo. The Ecliptic (like the Equator) is divided into 360 degrees, but not numbered from 1, 10, &c. as the Equator is. It is divided into 12 equal parts, containing 30 degrees each, which are called Signs, and have different names and characters.

Tyro. Pleaſe to let me know them.

Philo. I will; and you muſt mind to get the names of them by heart, and the character belonging to each, ſo as to know them at firſt ſight.

The SIGNS.

NORTHERN SIGNS.

Aries.	*Taurus.*	*Gemini.*	*Cancer.*	*Leo.*	*Virgo.*
♈	♉	♊	♋	♌	♍

SOUTHERN.

Libra.	*Scorpio.*	*Sagittarius.*	*Capricornus.*	*Aquarius*	*Piſces.*
♎	♏	♐	♑	♒	♓

☞ Take notice, the firſt ſix are called the Northern, the other the Southern Signs; and you are to mind which are oppoſite to each other (for that is very material) as ♈ is oppoſite to ♎, ♐ to ♊, &c. for it will ſhew you the different times and ſeaſons of the year, &c. very readily, when you come to perform any operation.

Tyro. I will obſerve what you ſay; but pleaſe to tell me the ſignification of their names.

Philo. It is of no great ſervice; however, here they follow: Aries ♈, or the Ram; Taurus ♉ the Bull; Gemini ♊ the Twins; Cancer ♋ the Crab; Leo ♌ the Lion; Virgo ♍ the Virgin; Libra ♎ the Balance; Scorpio ♏ the Scorpion; Sagittarius ♐ the Archer; Capricornus ♑ the Goat, Aquarius ♒ the Water-bearer; and Piſces ♓ the Fiſhes.

Tyro. Pray, Sir, inform me why the ancient aſtronomers affixed ſuch images as the Ram, the Bull, &c. to the 12 Signs of the Zodiac.

Philo. It is not eaſy to give a poſitive anſwer to your queſtion; but there is great reaſon to ſuppoſe that they were placed as Hieroglyphics of the ſeaſons of the year, alluding to the annual courſe of the Sun.

Thus, Aries, Taurus, and Gemini, repreſent March, April, and May, the ſpring quarter of the year, when Lambs, Calves and, Goats (the latter generally bringing forth twin kids) are produced.

Cancer, the Crab, which creeps both ways, repreſents the increaſe and decreaſe of the Sun's declination, to and from the ſummer ſolſtice, in June.

Leo, the Lion, intimates the raging heat of the ſun in July, which the ancients compared to the furious nature of that fierce animal.

Virgo, the Virgin, with a ſpike or ear of corn in her hand, properly repreſents Auguſt, when the harveſt of the earth is ripe.

Libra, the Balance, is diſplayed in September, to intimate that the days and nights, at the autumnal Equinox, are equal in all parts of the globe.

Scorpio, the Scorpion, a noxious animal, is placed as the Hieroglyphic of October; becauſe at that ſeaſon, diſeaſes of various kinds too often rage.

Sagittarius, the Archer, marks November, as the proper time for hunting.

Capricornus, the Goat, by its climbing up the rocks, is placed as an emblem of December, when the ſun, at the winter ſolſtice, begins to aſcend again towards the Equinoctial.

Aquarius, the Water-bearer, with his urn, repreſents January, when rains are frequent.

Piſces, the Fiſhes, are emblems of the fiſhing ſeaſon, which began in the Nile during the month of February.

N. B. The Ecliptic cuts, or interſects the Equator, or Equinoctial, at the two points, or ſigns, Aries ♈ and Libra ♎, viz. on the 21ſt of March, and the 22d of September, N. S. on which days the ſun is in the Equator, and has no declination, either N. or S. and the days and nights are then equal to all the Inhabitants on the globe, as you will plainly ſee by and by.

3. *Of the* BRAZEN MERIDIAN.

Tyro. What is the Brazen Meridian?

Philo. The Brazen Meridian is another great circle, which divides the Globe into two equal parts, called the Eaſtern and Weſtern hemiſpheres, whoſe poles are in the Eaſt and Weſt points of the Horizon. It is repreſented by a thick braſs hoop, which ſurrounds the Globe, from N. to S. and divides the Equator into 2 equal parts, viz. the E. and the W. and is that on which the Globe itſelf is hung, or turns round upon its axis, the extremities of which are called the poles.

Tyro. How is the Brazen Meridian marked, or divided?

Philo. Like the Equator and Ecliptic, into 360 degrees; but with this difference, it is divided into 4 nineties.

Tyro. In what manner, pray?

Philo. From the Equator towards the N. and S. Pole, the Meridan is marked with a cypher over the Equator, thus (0); and on each ſide, with 10, 20, 30, 40, 50, 60, 70, 80, and 90, which ends in each pole. Then again, from each pole to the Equator on the other half of the Meridian, is marked 10, 20, 30, 40, &c. to 90, which ends in the Equator.

Tyro. Then I plainly perceive by this, that as many degrees as one pole is elevated or raiſed, ſo many degrees will the contrary pole be depreſſed.

Philo. Your notion is very juſt.

Tyro. But pray, what is the principal uſe of this circle?

Philo. The Brazen Meridian ſhews you the latitude of places, and their difference of latitude, either N. or S. from the Equator: for the latitude of a place is the ſame as the elevation of the pole above the Horizon. That is, whatever figure, or number, the Horizon cuts the Meridian in, ſo many degrees is the pole elevated, which is the latitude, as you will more plainly ſee when we come to ſpeak of latitude and longitude.

4. *Of the* HORIZON.

Tyro. What is the Horizon?

Philo. The Horizon is that great circle which divides the heavens and earth into two equal parts, one called the upper, and the other the lower Hemiſphere, whoſe poles are in the Zenith and Nadir. There are two ſorts, the one called the ſenſible or apparent, the other the rational or real Horizon.

Tyro. What is the ſenſible Horizon?

Philo. The ſenſible Horizon is that which divides the viſible part of the heavens from the inviſible; and is that great circle which we ſee all round us (ſtanding upon any hill, or at ſea) juſt in the points where the heavens and earth ſeem to meet, or to be joined together.

Tyro. What is the rational Horizon?

Philo. The rational Horizon, is that which paſſes through the centre of the earth and divides it (as was ſaid before) into the upper and lower Hemiſphere.

☞ This rational Horizon is repreſented by that broad wooden circle, lying with its face upwards, having two notches cut in it, one in the N. and the other in the S. part, in which the Brazen Meridian is ſlipt, or moved up or down at pleaſure; the poles of the Horizon are the Zenith and Nadir.

Tyro. Pleaſe to give me a further deſcription of the Horizon.

Philo. If you uſe Senex's Globes, as improved by Martin, the Horizon plate will contain on its ſurface five circles.

1. The circle that is next the globe ſhews the Azimuth, &c.

2. The ſecond circle is that of Amplitude, &c.

3. The third circle contains the 32 points of the Mariner's compaſs.

4. The fourth is that of the Months and Days throughout the Year.

5. The fifth circle is the Ecliptic, and contains the marks, names, and figures of the 12 Signs of the Zodiac.*

Tyro. Sir, I thank you kindly. Pray, tell me now the uſe of the Horizon.

Philo. The Horizon ſhews the riſing and ſetting of the ſun, length of days and nights; alſo the riſing and ſetting of the ſtars in any latitude; together with the Azimuth, Amplitude, Almacanther, &c. of the ſun, or any ſtar, and the point they riſe or ſet upon, &c.

5. *Of the* COLURES.

Tyro. Pray. what are the Colures?

Philo. The Colures are two great circles, cutting the Equator at right angles, and paſſing through the poles of the world.

The Solſtitial Colure is that great circle which paſſes through Cancer and Capricorn, ſhewing Winter and Summer.

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* The modern globes have only four circles on the Horizon; that next the globe ſerving for both the Azimuth and Amplitude. The ſecond contains the points of the compaſs. The third is the Ecliptic. The fourth the months and days; and, on ſome globes, the Saints' Days.

The Equinoctial Colure paſſes through Aries and Libra, and ſhews the Spring and Autumn.

And, now, having given you a full deſcription of the great circles; I propoſe to deſcribe the leſſer, and ſhew you more of the nature of the globe, and the appendants belonging to it.

DIALOGUE VI.

Concerning the leſſer *Circles of the* Sphere, *commonly called* Parallel *Circles.*

SECT. I.

Tyro. WHAT do you mean by the leſſer, or parallel circles.

Philo. All ſuch circles as do not divide, or cut the globe into two equal parts, but that cut off any ſegment, or part, leſs than the half, are leſſer circles?

Tyro. Why are they called parallel circles?

Philo. Becauſe they are parallel every where to the Equator.

Tyro. Pray tell me the names of the leſſer circles.

Philo. They are the Tropics and Polar circles.

1. *Of the* TROPICS.

Tyro. Pray, which are the Tropic Circles?

Philo. Look for the ſign Cancer on the globe, and you will find a circle drawn with a double, or dotted, line from thence round the globe, parallel

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Tyro. Pray tell me the names of the leſſer circles.

Philo. They are the Tropics and Polar circles.

1. *Of the* TROPICS.

Tyro. Pray, which are the Tropic Circles?

Philo. Look for the ſign Cancer on the globe, and you will find a circle drawn with a double, or dotted, line from thence round the globe, parallel to the Equator, which is called the Northern Tropic, or Tropic of Cancer, being 23½ degrees from the Equator northward, ſhewing the Sun's greateſt northern declination. Then looking for the ſign Capricorn, you will find the ſame ſort of circle, which is called the *Southern Tropic*, being alſo 23½ degrees from the Equator, and ſhewing the Sun's greateſt ſouthern declination, or departure from the Equinoctial.

2. *Of the* POLAR CIRCLES.

Tyro. Which are the Polar Circles?

Philo. They are two ſmall circles, lying near the poles (viz. 23½ degrees diſtant from them) drawn alſo with double lines: that on the N. is called the Arctic circle, and that on the S. the Antarctic circle. They are called Polar Circles, from their being deſcribed by the revolution of the Poles of the Ecliptic, round the poles of the world, at 23 degrees, 30 minutes, diſtance from them, by a retrogade motion, in 25920 years; occaſioned by the preceſſion of the Equinoxes, 50 ſeconds every year.

Tyro. Pray, what is their uſe, or what do we learn from them?

Philo. All thoſe inhabitants that live under theſe lines have their longeſt day juſt 24 hours long, and their longeſt night the ſame (ſave the benefit of twilight, which is but trifling.) If you go further towards the poles, their days are 2, 3, and 4 days, or 2, 3, 4, or 6 months long, as you will find demonſtrated in the problems.

Tyro. Surpriſing! I long to ſee thoſe places, having heard of ſuch things, but always looked upon them as idle tales.

Philo. You may depend upon the truth of it, and will ſoon ſee the reaſon. But, now, we will ſhew you the Appendants belonging to the globes.

SECT. II.

Of the Appendants *belonging to the* Globes.

Tyro. WHAT do you mean by Appendants?

Philo. Appendants are in ſome reſpects the ſame as Appurtenances, being ſuch neceſſary things, both moveable and immoveable, as belong to globes; the principal or chief of which are as follow:

Of the Hour Circle, *and* Index.

Tyro. Pray what is the Hour Circle, and its uſe?

Philo. The Hour Circle, called alſo the Horary Circle, or Dial-Plate, is a ſmall circle of braſs, divided into 24 hours; the upper 12 repreſents noon, and the lower 12 midnight. It is ſcrewed on the meridian round the N. pole, and on the pole itſelf is placed the Index, or Hand, which turns round with the globe.*

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* For the greater conveniency of elevating the South Pole, and viewing the New Diſcoveries, the modern globes have the Hour Circle placed on the ſurface of the globe, under the braſs meridian, and not on the meridian, as above deſcribed.

Its uſe is to tell the time of the riſing and ſetting of the ſun, or ſtars, in any latitude; and what o'clock it is in any part of the world, &c.

2. *Of the* Quadrant *of* Altitude.

Tyro. Pray, what is the Quadrant of Altitude?

Philo. This is a thin piece of pliable braſs, divided into 90 degrees, anſwering to the degrees of the equator, beginning at the lower end with (0) and proceeding to 10, 20, 30, &c. till we come to 90. At which figure it has a nut, which ſlips upon the meridian at pleaſure, and is faſtened thereto by a ſcrew.

Tyro. Pray, what is the chief uſe of this Appendant?

Philo. Its uſe is to tell the height of the ſun, or ſtars, at any hour, and when they are due E. or W. Alſo the diſtance of the ſtars from one another, and the diſtance of one place from another on the terreſtrial globe, &c. &c. &c.

3. *Of the* Semi-circle.

Tyro. What is the Semi-circle of poſition?

Philo. It is a thin piece of braſs, divided into 180 degrees, anſwering to one half of the Equator. It may be called a double quadrant of Altitude, but is uſed only in ſome particular problems, the Quadrant, or Horizon, in general, ſupplying its place.

4. *Of the* Nautical Box, *or* Mariner's Compaſs.

Tyro. What is the Nautical Box, and its uſe?

Philo. This is an inſtrument uſed in navigation, having the 32 points of the wind marked, or drawn, on a Card, and a needle being touched with the load-ſtone points always northward. This Compaſs is ſometimes fixed in the bottom of the frame, under the centre of the globe, for the purpoſe of placing the globe in a right poſition; viz. ſo as for the four cardinal points of the Horizon to be directed towards their correſponding points in the heavens.

SECT. III.

Concerning the different Names of the Sphere, *according to its different Poſition, or Situation.*

Tyro. WHAT do you mean by the Sphere's having different names, according to its poſition? I do not underſtand you.

Philo. Obſerve then. There are 3 ſorts of Spheres; viz. a Parallel, a Right, and an Oblique Sphere.

1. *A* Parallel Sphere.

1. A Parallel Sphere is ſo called, becauſe under it the Equator coincides, or is parallel with the Horizon. 2. The Poles are in the Zenith and Nadir; that is, one pole is right up, and the other right underneath.

Properties *of this* Sphere.

The inhabitants of this Sphere are thoſe that live under the poles, who have but one day and one night in the year. This day continues ſix months, while the ſun paſſes through ſix of the ſigns of the Zodiac; and the night ſix months, while he paſſes through the other ſix. The day to thoſe who live under the North pole begins when the ſun enters Aries, and continues till he reaches Libra; when night commences, and continues the other ſix months. Thoſe who live under the South pole experience the direct contrary, it being day with them when it is night with the former, and *vice verſa*. But both enjoy a long continuance of twilight, both after the ſun has departed, and before he appears.

Tyro. Pray, Sir, what do the polar inhabitants (if there be any) obſerve with reſpect to the ſun, moon, and ſtars?

Philo. 1. They ſee the ſun for half the year, moving continually round above the Horizon, in a ſpiral line, the firſt round ſkimming the ſkirts of the Horizon; the ſecond higher, and ſo on, till by 90 revolutions he has reached the Tropic, his utmoſt declination; after which, by 90 more revolutions, he again reaches the Horizon, and then their long winter's night begins.

2. They ſee the moon during their ſummer's day only as a white cloud in the ſky; and in the winter, during her ſecond and third quarters, ſhe moves as the ſun did, round and round for a continuance of ſeveral days without ſetting; being a fortnight above, and a fortnight under the Horizon.

3. They can only ſee that hemiſphere of ſtars between the Pole and the Equator, the feweſt

ſeen by any of the inhabitants of the earth. During half a year they ſee none, (the ſtars being ſwallowed up in the ſuperior light of the ſun) and their view of them is but ſhort in the winter's night, by reaſon of the long twilight. To them the ſtars never ſet, but move in circles parallel to the Horizon, keeping always the ſame altitude. The planets are half their time above, and half below the Horizon.

2. *A* Right Sphere.

1. A right Sphere is ſo called, becauſe under it the Equator cuts the Horizon at right angles.

2. The poles will lie, or be in the Horizon.

3. The Equator will be in the Zenith and Nadir.

Properties *of this* Sphere.

The inhabitants of this Sphere are thoſe who live under the Equinoctial Line, or Equator, and have their days and nights always equal; *viz.* 12 hours each; becauſe not only the Equator, but alſo all the Parallels are cut into two equal parts by the Horizon. And therefore as the ſun's diurnal arches are equal to the nocturnal, each day muſt be equal to the night, *viz.* 12 hours each.

Tyro. How do the ſun, moon, and ſtars appear to the inhabitants under the Equinoctial.

Philo. The ſun riſes and ſets nearly perpendicular, nor can he have more than 23 degrees, 30 minutes, either North or South amplitude.

He comes to the Meridian with the ſame degree of the Equator with which he roſe; and hence there can be no aſcenſional difference. He is half a year on one ſide of their Zenith, and as much on the other; paſſing over their Zenith twice a year, *viz.* at the Equinoxes.

With regard to the moon, there is nothing uncommon, or different in her appearances, from thoſe in an oblique ſphere, except her riſing and ſetting nearly in a perpendicular direction like the ſun.

But here is a glorious diſplay of all the ſtars in the heavens, from pole to pole; all of them riſing and ſetting perpendicular to the Horizon, except the pole ſtars, which lying in the Horizon, are rendered inviſible by the denſeneſs of the atmoſphere. The twilight is ſhorter in this ſphere than in any other, for the ſame reaſon that it is ſhorteſt with us at the Equinox.

3. *An* Oblique Sphere.

An Oblique Sphere is that poſition of the globe, which all the inhabitants of the earth, excepting thoſe under the Poles and Equinoctial, enjoy; and is ſo called, becauſe under it the Equator cuts the Horizon obliquely.

Properties *of this* Sphere.

1. The pole is elevated to any degree leſs than 90, the axis of the earth always making an acute angle with the Horizon.

2. All the parallels to the Equator cut the Horizon obliquely, making the diurnal greater

or leſs than the nocturnal arches; and conſequently producing an inequality in the days and nights, which are never equal but when the ſun is in Aries and Libra, which happens in March and September, when he moves in the Equator, making equal days and nights to all the inhabitants of the earth, except thoſe under the poles.

3. The inhabitants of this Sphere, who live without the tropics, never have the ſun in their Zenith; though they may ſometimes ſee the moon there, on account of her latitude: but under the tropics the ſun is vertical once, and to every place between the tropics and the Equator twice every year.

4. The ſtars riſe and ſet obliquely in this poſition; and the nearer the obſerver is ſituated to the Equator, the greater number of them will be viſible. The length of the twilight is longer or ſhorter in this poſition, according as the latitude is greater or leſs.

5. The moon, when at full, being always in an oppoſite ſign to the ſun, muſt, in ſummer, be in the winter ſigns, and conſequently make a ſhort, low courſe. But in winter ſhe will move through the ſummer ſigns, making a high, long circuit; which is of great uſe in that dreary ſeaſon.

SECT. IV.

Of the different Names of the Inhabitants of the Globe, *with reſpect to their Situation.*

Tyro. YOU have already explained to me the three different poſitions of the Sphere; pray, what do you mean by the names of the ſeveral inhabitants?

Philo. Without any regard to the different poſitions of the Sphere, theſe inhabitants have different names according to the ſeveral meridians and parallels of latitude they lie under.

Tyro. Pleaſe to tell me their different names.

Philo. There are 6 different kinds of inhabitants; 1. Antœci. 2. Periœci. 3. Antipodes. 4. Amphiſcii. 5. Periſcii. And 6. Heteroſcii.

1. *Of the* ANTOECI.

The Antœci, or Antœcians, are thoſe inhabitants that have the ſame longitude with us, that is, lie under the ſame meridian; but they are as far to the S. of the Equator, as we are to the N.

Their Properties.

1. Their hour is the ſame as ours, it being noon, &c. with both at the ſame time. 2. Their days are equal to our nights, and *vice verſa*. And 3. Their ſummer is our winter.

2. *Of the* PERIOECI.

The Periœcians are thoſe that lie under the ſame parallel of latitude with us, on the ſame ſide of the Equator, only are diſtant 180 degrees of longitude; viz. a ſemi-circle.

Their Properties.

1. They have contrary hours; it being noon with them when it is midnight with us. 2. Their days and nights are of the ſame length as ours. 3. Their ſeaſon, or time of the year, is alſo the ſame as with us.

3. *Of the* ANTIPODES.

The Antipodes are ſuch inhabitants as have the ſame latitude S. as we have N. but differ 180 degrees in longitude. That is, they and we have oppoſite parallels, and oppoſite meridians.

Their Properties.

1. Their hour is directly the reverſe of ours, it being noon with them, when it is midnight with us. 2. Their longeſt day is our ſhorteſt day, and their longeſt night our ſhorteſt night. And 3. The four ſeaſons are contrary, their ſummer being our winter, &c. &c.

Tyro. It is wonderful indeed! I have often heard, it is true, that there are ſuch perſons as walk with their feet to our feet (that is, go with their heads downwards in reſpect of us:) pray are not the Antipodes this ſort of people?

Philo. They are, and however ſtrange it may ſeem, it is certainly true; and this you will eaſily ſee, when you come to the problems, if you will have but a little patience.

Tyro. Sir, I am obliged to you, and will be content till then. Pleaſe now to tell me concerning the other three kinds of inhabitants?

Philo. They have their names from the different poſitions of their ſhadows.

4. *Of the* AMPHISCII.

They are ſo called, becauſe their ſhadows are caſt different ways, at noon day, at different times of the year; that is, their ſhadow ſometimes points to the North, and ſometimes to the South. Therefore, it is eaſy to perceive that theſe people live in the Torrid Zone, that is, between the Tropics.

5. *Of the* PERISCII.

Theſe are ſo called becauſe their ſhadows go quite round them. Such are the inhabitants that dwell within the Polar Circles, that is, from 66½ degrees of latitude to 90, where the ſun for part of the year never ſetting, but moving round the Horizon, makes the ſhadows of the people likewiſe move around them.

6. *Of the* HETEROSII.

They are ſo called, as having their ſhadow caſt but one way, that is, either always towards the N. or always towards the S.

Theſe are ſuch as live in the Temperate Zones; that is, between the Tropics and the Polar Circles. Thoſe in the South Temperate Zone have their ſhadows caſt always ſouthward;

and thoſe in the North Temperate Zone have their ſhadows always caſt northward, as in England, France, Spain, and moſt other parts of Europe.

SECT. V.

Of the ZONES, *and* CLIMATES.

1. *Of the* ZONES.

Tyro. WHAT do you mean by the Zones?

Philo. A Zone, or Girdle, is a tract, or ſpace, that ſurrounds the ſurface of the earth, as a Belt, or Girdle, does the body.

Tyro. How many Zones are there;

Philo. Five; viz. One Torrid Zone, two Temperate Zones, and two Frigid Zones.

Tyro. You gave me an account of their different ſituations in the laſt ſection; be pleaſed, now, to tell me their extent, that I may have a better idea of the diviſion of the globes.

Philo. You remember that I told you from the Equator to either Pole is 90 degrees; therefore, from the N. to the S. Pole is 180 degrees. Obſerve then,

1. The Torrid Zone extends from the Equator to the Tropic of Cancer northward, and to the Tropic of Capricorn ſouthward, 23½ degrees each way, viz. 47 degrees in all.

2. The Temperate Zones extend themſelves from the two Tropics to the Polar Circles on both ſides of the Equator; each of them containing 43 degrees, or 86 degrees together.

3. The Frigid Zones extend from the Polar Circles to the Poles, being each 23½ degrees, or 47 together; for 23½, 43, and 23½, make 90 degrees; the diſtance from the Equator to either Pole. Or rather thus, the Torrid Zone contains 47 degrees, the Temperate Zones 86, and the Frigid 47, in all 180 degrees.

Tyro. Sir, I thank you for this explanation; it is very eaſy to be underſtood: pleaſe, now, to tell me what you mean by the climates?

2. *Of the* CLIMATES.

Philo. Climates are tracts, or circles upon the ſurface of the globe, parallel to the Equator, of ſuch a certain breadth, that the artificial day in each (viz. from ſun-riſe to ſun-ſet) exceeds that in the next climate nearer the Equator by half an hour, till you come to the Polar Circles, and then, indeed, the day encreaſes in each climate by one entire month.

Tyro. How many Climates * are there that differ by the half hour, and how many by the entire month?

Philo. There are 60 Climates in all, viz. 30 on each ſide of the Equator, called accordingly North and South: of theſe 60, 48 extend from the Equator to the Polar Circles, and each differs by half an hour. And the remaining 12 are contained between the Polar Circles and the Poles, each differing one entire month from the other.

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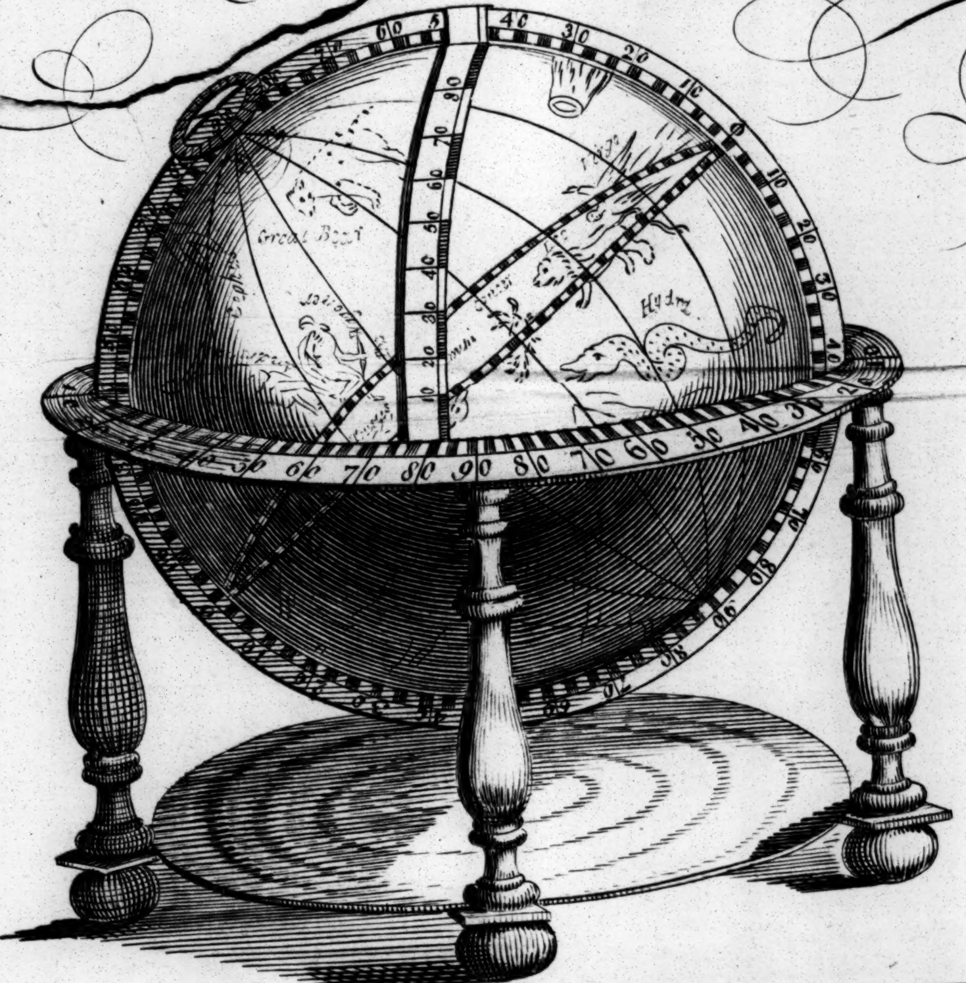
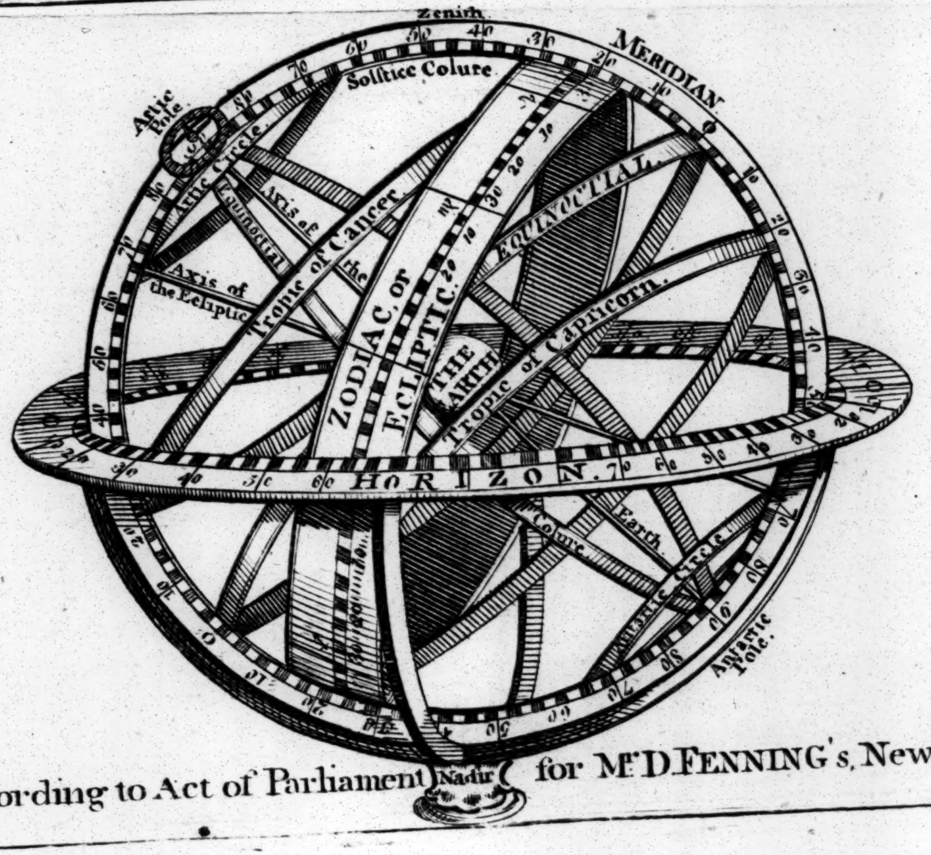
* Great Britain extends from the middle of the 9th to about the middle of the 13th North Climate; viz. about four Climates.

BIBLIOTHECA · ECCL · [illegible]

THE
CŒLESTIAL GLOBE AND SPHERE.



Powell Sculpt.



Engrav'd According to Act of Parliament for Mr. D. FENNING's, New Uſe of the Globes.

DIALOGUE VII.

An Explanation of the moſt common Terms uſed in Geography *and* Aſtronomy.

SECT. I.

Tyro. YOU have, Sir, given me a very clear and ſatisfactory account of the nature and properties of the globe: I will now trouble you to explain the terms to me; for what can I do, till I know the ſignification of ſuch words as are uſed in the ſcience.

Philo. It is very true, and I will explain them as well as I am able; and pray, be careful to get them by heart, though not juſt in the very words I uſe, yet ſo as to know the meaning of them, and the practical part will then eaſily follow; for the want of this is the chief reaſon that moſt learners are ſo deficient in what they undertake.

Tyro. You may depend upon my care.

Philo. Very well; I am ſatisfied, in hopes of your keeping your promiſe.

Explanation *of the Terms.*

1 Zenith, is that point of the heavens that is right over our head.

2. Nadir, is that point right under our feet, being directly, or diametrically, oppoſite to the Zenith.

3. Zenith Diſtance, is the number of degrees that the ſun, or any ſtar, wants of 90 degrees, when they are upon the meridian, or greateſt height.

4. Altitude is height. Meridian Altitude is the greateſt Altitude, or height, at 12 o'clock.

5. Declination, is the diſtance of the ſun, or any ſtar, from the Equator or Equinoctial, counted on the Brazen Meridian in degrees, and is called North, or South, according to the ſide of the Equinoctial on which the declination is.

6. Right Aſcenſion, is an Arch of the Equinoctial, contained between the ſign Aries ♈, and the degree of the Equinoctial that is cut by the Brazen Meridian, when the ſun, or ſtar, is brought to the Meridian.

7. Oblique Aſcenſion, is that Arch of the Equinoctial contained between the ſign ♈, and the degree of the Equinoctial, which is cut by the Horizon at the riſing of the ſun, or ſtar.

8. Oblique Deſcenſion, is juſt the reverſe, being that Arch of the Equinoctial, contained between the ſign Aries and the degree of the Equinoctial, that is cut by the Horizon, at the ſetting of the ſun, or ſtar.

9. Aſcenſional Difference, is the difference of degrees, between the right and oblique Aſcenſion, which converted into time, by allowing 15 degrees for every hour, ſhews how much the ſun, or ſtar, riſes, or ſets, before or after ſix. That is, ſubſtract the leſs from the greater number, and the remainder will give the aſcenſional difference.

10. Amplitude, is an Arch of the Horizon, contained between the true E. or W. point, and that degree of the Horizon where the ſun or

ſtars riſe or ſet, and is called North, or South Amplitude, accordingly.

11 Azimuth, is in effect the ſame as Amplitude, ſave only with this difference; that whereas Amplitude is only at riſing and ſetting, Azimuth ſhews the diſtance from the E. and W. points, at any time, when the ſun, or ſtars, are above the Horizon.*

12. Almacanthers are circles of Altitude paſſing through every degree and minute of the Meridian, parallel to the Horizon.

13. Elevation of the pole, is the ſame as Latitude. There are three ſorts, viz.

1. Latitude of a place, is its diſtance from the Equator, either North or South, numbered in Degrees on the Brazen Meridian: or, in other words, it it the Elevation of the Pole above the Horizon.

2. Latitude (in Navigation) is the diſtance of a ſhip from the Equinoctial, counted on the Meridian. So that if a ſhip ſails towards the Equinoctial, ſhe is ſaid to depreſs the pole; and, if ſhe ſails from the Equinoctial, ſhe is ſaid to raiſe the pole.

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* *Note*, *Azimuth* is not expreſſed alike in all authors. Some call it always *North* or *South Azimuth*, and reckon the *Azimuth* from theſe two points eaſtward, or weſtward. Others reckon it from the E. and W. points, either northward or ſouthward, which, I think, is beſt, theſe being the two points that *Azimuth* is neareſt to in our, or any leſſer latitude, at any hour: however, it matters not which way you reckon, if you mind this one rule; ſuppoſe I ſay, the ſun has 60 degrees *Azimuth* from the N. eaſtward, it is the ſame as if I ſay he has 30 degrees *Azimuth* from the E. northward. See PROBLEM XXI.

3. Latitude of a ſtar, is its diſtance from the Ecliptic, being an arch of a circle of longitude, reckoned from the Ecliptic towards its pole either N. or S.

14. Longitude is alſo of three ſorts, viz.

1. Longitude of a place, is an Arch of the Equator, intercepted between the firſt Meridian on the Equator and the Meridian of the place.*

2. Longitude of a ſtar, is an Arch of the Ecliptic, counted from the beginning of Aries, to the place where the ſtar's circle of longitude croſſes the Ecliptic; ſo that it may be ſaid to be the ſtar's place in the Ecliptic, counted from the point Aries, which cannot exceed 180 degrees from the Equinoctial point.

3. Longitude (in Navigation) is an Arch of the Equator, contained between the firſt Meridian and the Meridian the ſhip is on.

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* *Note,* The *Longitude* of places differs according as you fix your firſt *Meridian.* Thus, upon ſome globes, *London* is 23 degrees E. longitude, on others 20, *&c.* and on all *Senex's* globes 18 degrees E. longitude from the firſt *Meridian.* For ſome place their firſt *Meridian* at *Gratioſo,* others at *Teneriff,* and *Senex* at *Ferro.* But this matters not at all; for when you know the difference (as you will ſoon learn that by practice) you will know how to work by either, and have the anſwers accordingly.

N. B. In reckoning longitude from *London,* you will find at 18 degrees from *Aries* eaſtward on *Senex's* globe, a cypher (0) on the lower part of the *Equator,* under the meridian of *London,* and there begins the longitude from *London,* viz. Longitude extends 180 degrees eaſtward, numbered by 10, 20, 30, *&c.* No longitude exceeds 180; for 181 E. is more properly 179 W. longitude.

Tyro. I humbly thank you, Sir, for theſe definitions, which when well underſtood, muſt render the uſe of the globes very eaſy.

Philo. Indeed, my dear pupil, there can be nothing hard in the practical part, when once you have a tolerable notion of what I have ſhewn you.

But, becauſe I would have you underſtand yet more, I have inſerted the following tables (which are not to be found in any other ſmall treatiſe I ever ſaw) that you may not be at a loſs, when you work any curious problems, but may be able to refer to them, both for inſtruction and confirmation.

SECT. II.

Containing four TABLES *that are not only uſeful but indiſpenſably neceſſary to the right Underſtanding the Uſe of the Globes, viz.*

TABLE I.

A TABLE *of the* Latitude *and* Longitude *of the moſt remarkable* Places, *from the* lateſt *Obſervations.*

Places	Latitude.		Longitude.	
	°	′	°	′
Adrianople, Turkey, in Europe	42	00N.	26	30E.
Aix la Chapelle, in Weſtphalia	50	45N.	5	50E.
Aleppo, Syria, in Aſia -	35	45N.	37	25E.
Alexandria, Egypt, in Africa	31	11N.	30	21E.
Amſterdam, in Holland (and capital) - -	52	23N.	4	51E.
Archangel, in Ruſſia -	64	34N.	39	00E.
Babylon, in Chaldea (called Bagdad) - -	33	00N.	42	52E.
Barbadoes, in the Weſt Indies	13	00N.	59	50W.
Batavia, Eaſt-Indies -	6	10S.	106	57E.
Berlin, Upper Saxony, in Germany - -	52	33N.	13	30E.
Bologne, Picardy, in France	50	44N.	1	42E.
Boſton, New England, America	42	25N.	70	32W.
Botany Bay - -	33	50S.	151	00E.
Briſtol, in England -	51	28N.	2	40W.
Cadiz, Andaluſia, in Spain -	36	31N.	6	06W.
Cairo, Egypt, in Africa -	30	03N.	31	31E.
Calcutta, Bengal, in the Eaſt-Indies - - -	22	34N.	88	34E.
Candia, in the Iſland of Candia	35	19N.	25	25E.
Canterbury, in Kent -	51	16N.	1	15E.
Canton, in China - -	23	08N.	113	8E.
Candy, in the Iſland of Ceylon	7	54N.	79	00E.

Places.	Latitude.	Longitude
	° ′	° ′
Cape of Good Hope, Africa	34 29S.	18 30E.
Charles-Town (Carolina) N. America - -	32 45N.	79 12W.
Cochin, Eaſt-Indies - -	9 50N.	76 05E.
Conſtantinople, Romania, in Turkey (and capital)	41 00N.	28 58E.
Copenhagen, Zeland, in Denmark (and capital) - -	55 41N.	12 41E.
Corinth, Morea, in Turkey	37 30N.	23 00E.
Cork, Ireland - -	51 54N.	8 23W.
Cracow, Poland - -	50 10N.	19 55E.
Cremona, Milan, in Italy -	45 10N.	10 32E.
Cyprus Iſland, in the Levant	35 00N.	34 00E.
Dublin, capital of Ireland -	53 21N.	6 01W.
Dunkirk, Flanders -	51 02N.	2 27E.
Edinburgh, capital of Scotland	55 58N.	3 07W.
Epheſus, Natolia, in Aſia -	38 00N.	27 35E.
Florence, Italy - -	43 46N.	11 08E.
Frankfort, on the Main, in Germany - - -	49 55N.	8 40E.
Gibraltar, Andaluſia, in Spain	36 06N.	5 17W.
Glaſgow, in Scotland -	55 52N.	4 10W.
Hague, in Holland -	52 04N.	4 23E.
Hanover, Saxony, in Germany	52 32N.	9 35E.
Jeruſalem, Paleſtine, in Aſia	31 55N.	35 25E.
Koningſburgh, Pruſſia in Poland - -	54 43N.	21 35E.
Lima, in Peru, in S. America	12 01S.	76 45W.
Liſbon, capital of Portugal	38 42N.	9 04W.
London, capital, or metropolis, of England - -	51 32N.	0 00
Madras, Coromandel, Eaſt-Indies	13 05N.	80 33E.
Madrid, New Caſtile, in Spain, (and capital) - -	40 25N.	3 20W.

Places.	Latitude.		Longitude.	
	°	'	°	'
Malta, near Sicily, in the Mediterranean - -	35	54N.	14	34E.
Mexico, N. America -	19	54N.	100	00W.
Moſcow, Ruſſia - -	55	45N.	37	51E.
Nankin, or Nanquin, in China	32	07N.	118	35E.
Naples, in Italy - - - -	40	51N.	14	19E.
St. Omer's, French Netherlands	50	45N.	2	20E.
Panama, S. America -	8	48N.	80	14W.
Paris, capital of France, -	48	50N.	2	25E.
Pekin, in China - - -	39	54N.	116	30E.
Peterſburgh, the capital of Ruſſia	60	00N.	30	25E.
Philadelphia, N. America -	39	57N.	75	08W.
Port Royal, Jamaica - -	18	00N.	77	00W.
Prague, capital of Bohemia, in Germany - - - -	50	05N.	14	50E.
Preſburgh, in Hungary -	48	22N.	17	30E.
Quebec, in Canada, N. America	46	55N.	69	48W.
Rhodes Iſland, Archipelago -	36	00N.	28	00E.
Rome, capital of Italy -	41	54N.	12	34E.
Siam, in the Eaſt-Indies -	14	18N.	100	55E.
Spires, Upper Rhine, Germany	49	00N.	8	10E.
Stockholm, capital of Sweden	59	20N.	18	08E.
Syracuſe, Sicily - -	37	04N.	15	20E.
Tangier, Barbary, in Africa	35	55N.	5	45W.
Thyatira, Natolia, Aſia -	38	28N.	28	32E.
Tripoli, Barbary, Africa -	32	54N.	13	10E.
Tunis, ditto - - -	36	47N.	10	16E.
Venice, Italy - - -	45	26N.	12	10E.
Vienna, Germany (capital)	48	13N.	16	28E.
Warſaw, the capital of Poland	52	14N.	21	06E.
York, in England - -	54	00N.	1	02W.
York (New) N. America	40	43N.	74	04W.

Greenwich Obſervatory, Kent, England, lat. 51° 28' 40'' N. long, 0° 5' 37'' E. of St. Paul's, London.

TABLE

TABLE II.

SHEWING

The Number of Miles contained in a Degree of Longitude, at every Degree of Latitude, from the Equator.

Degrees of Latitude	Miles.	100th Parts of a Mile.	Degrees of Latitude.	Miles.	100th Parts of a Mile.	Degrees of Latitude.	Miles.	100th Parts of a Mile.
1	59	99	31	51	43	61	29	09
2	59	96	32	50	88	62	28	17
3	59	92	33	50	32	63	27	24
4	59	85	34	49	74	64	26	30
5	59	77	35	49	15	65	25	36
6	59	67	36	48	54	66	24	40
7	59	56	37	47	92	67	23	45
8	59	42	38	47	28	68	22	48
9	59	26	39	46	63	69	21	50
10	59	09	40	45	95	70	20	52
11	58	89	41	45	28	71	19	54
12	58	69	42	44	59	72	18	54
13	58	46	43	43	88	73	17	54
14	58	22	44	43	16	74	16	54
15	57	95	45	42	43	75	15	53
16	57	67	46	41	68	76	14	52
17	57	38	47	40	92	77	13	50
18	57	06	48	40	15	78	12	48
19	56	73	49	39	36	79	11	45
20	56	38	50	38	57	80	10	42
21	56	02	51	37	76	81	09	38
22	55	63	52	36	94	82	08	35
23	55	23	53	36	11	83	07	31
24	54	81	54	35	27	84	06	27
25	54	38	55	34	41	85	05	23
26	53	93	56	33	55	86	04	18
27	53	46	57	32	68	87	03	14
28	52	97	58	31	80	88	02	09
29	52	48	59	30	90	89	01	05
30	51	96	60	30	00	90	00	00

TABLE III.

OF THE CLIMATES.

From the Equator to the Polar Circles.				
Climates.	Ends in Latitude of		Where the longest Day is	
	Deg.	Min.	H.	Min.
1	8	34	12	30
2	16	42	13	
3	24	10	13	30
[illegible]	30	46	14	
5	36	28	14	30
[illegible]	41	22	15	
7	45	29	15	30
8	[illegible]	1	16	
9	51	58	16	30
10	54	27	17	
11	56	37	17	30
12	58	29	18	
From the Polar Circles to the Poles.				
1	67	21	1	Months
2	69	48	2	
3	73	37	3	

From the Equator to the Polar Circles.				
Climates.	Ends in Latitude of		Where the longest Day is	
	Deg.	Min.	H.	Min.
13	59	58	18	30
14	61	18	19	
15	62	25	19	30
16	63	22	20	
17	64	8	20	30
18	64	49	21	
19	65	21	21	30
20	65	47	22	
21	66	6	22	30
22	66	20	23	
23	66	28	23	30
24	66	31	24	
From the Polar Circles to the Poles.				
4	78	30	4	Months
5	84	5	5	
6	90	0	6	

T A B L E IV.

A Table *of the right* Aſcenſion, Declination, Latitude, *and* Longitude *of ſome of the moſt eminent fixed* Stars, *taken from* Senex's *Celeſtial* Globe, 1754, *for the Uſe of the Learner*; *and now rectified to the Beginning of the Year* 1799, *with Additions.*

Names and Conſtellations.	R.	A.	Declin.		Lat.		Long.		
	°	'	°	'	°	'	°	'	
Aldebaran, in Taurus* -	66	00	16	5N.	5	29S.	6	53	♊
Algenib, in Pegaſus* - -	00	38	14	2N.	12	35N.	6	17	♈
Alioth, in Urſa Major -	191	12	57	5N.	54	18N.	5	50	♍
Alcair, or Atair, in Aquila*	295	9	8	20N.	29	19N.	28	49	♑
Albiero, in Cygnus -	290	35	27	32N.	49	2N.	28	23	♑
Arideſ, in ditto -	308	35	44	33N.	59	56N.	2	27	♓
Achernar, in Eridanus -	22	29	58	18S.	59	18S.	12	7	♓
Alfeta, in Corona -	231	29	27	26N.	44	23N.	9	17	♏
Arcturus, in Bootes -	211	34	20	18N.	30	57N.	21	20	♎
Arietis, in Aries* - -	28	52	22	28N.	9	57N.	4	45	♉
Aſengue, in Lyra -	277	28	38	36N.	61	45N.	12	22	♑

Names and Conſtellations.	R. A. °	'	Declin. °	'	Lat. °	'	Long. °	'	
Bellatrix, in Orion -	78	30	6	9N.	16	53S.	18	2	♊
Betelgeuze, in ditto -	85	59	7	21N.	16	4S.	25	50	♊
Benenaez, in Urſa Major -	204	50	50	21N.	54	25N.	23	51	♍
Canobus, or Canopus, in Argo Navis	94	50	52	35S.	75	51S.	12	11	♋
Caſtor, in Gemini - -	110	19	32	20N.	10	4N.	17	21	♋
Caſtor's Brothe, Pollux, ditto* -	113	8	28	31N.	6	39N.	20	21	♋
Capella, in Auriga - -	75	20	45	46N.	22	52N.	18	57	♊
Cor Hydræ, Hydra's Heart, -	139	20	7	46S.	22	24S.	24	25	♌
Cor Scorpionis, Scorpio's Heart*	244	10	25	57S.	4	31S.	6	51	♐
Cor Leonis, called Regulus* -	149	19	12	59N.	0	27N.	26	57	♌
Deneb, in Leo Major -	174	37	15	44N.	12	17N.	18	45	♍
Enif, in Pegaſus - -	323	29	8	56N.	22	8N.	29	1	♒
Fomalhaut, in Southern Fiſh* -	341	32	30	43S.	21	4S.	0	54	♓
Gauby, in Libra's South Scale -	219	52	15	10S.	0	22N.	12	11	♏
Marhal, or Markab, in Pegaſus	343	36	14	5N.	19	26N.	20	35	♓
Menkar, in Cetus -	42	51	3	16N.	12	37S.	11	26	♉
Procyon, in Canicula -	112	6	5	45N.	15	58S.	22	55	♋

Names and Conſtellations.	R.	A.	Declin.		Lat.		Long.		
	°	′	°	′	°	′	°	′	
Pes Centauri - - -	216	29	59	58S.	42	28S.	27	3	♏
Regel, or Rigel, in Orion's Foot	76	8	8	27S.	31	10S.	13	55	♊
1. Star in the Girdle of Orion	80	21	0	28S.	23	36S.	19	27	♊
2. —— ditto - -	81	25	1	21S.	24	33S.	20	34	♊
3. —— ditto - -	82	34	2	4S.	25	21S.	21	46	♊
Scheat, in Pegaſus - -	343	25	26	57N.	31	7N.	26	28	♓
Sheder, in Caſſiopeia -	7	12	55	24N.	46	36N.	4	56	♉
Sirius, in Canis Major -	99	0	16	26S.	39	32S.	11	14	♋
Spica, in Virgo* - -	198	34	10	4S.	2	2S.	20	56	♎
Lower Pointer, in Urſa Major -	162	18	57	30N.	45	6N.	16	30	♌
Upper Pointer, in ditto, called Dubhe	162	42	62	52N.	49	40N.	12	13	♌
Vindemiatrix, in Virgo -	192	57	12	5N.	16	13N.	7	3	♎

☞ The Stars marked thus *, in the foregoing Table, are thoſe from which the diſtance of the Moon is calculated in the Nautical Almanack, for the purpoſe of aſcertaining longitude.

DIALOGUE VIII.

Containing ſome uſeful and neceſſary Problems *on the* Terreſtrial Globe.

N. B. (°) ſtand for degrees, (′) for minutes.

SECT. I.

Philo. YOU ſay, *Tyro*, that you underſtand what I have ſhewn you concerning the nature of the globes, and the appendants that belong to them; and, if ſo, you are fit for the following problems: but, if you think you are not perfectly maſter of theſe ſubjects, or do not underſtand what right Aſcenſion, oblique Aſcenſion, Azimuth, Almacanthers, &c. ſignify, or do not know what the greater or leſſer circles are, and the particular uſes of the Meridian, Horizon, Colures, Quadrant of Altitude, &c. then, pray, turn back, and read them over once more; for you will find that your underſtanding theſe will be a great help to you in the ſolution of geographical problems.

Tyro. I thank you for your care; but I underſtand them in general very well.

Philo. Then I will directly proceed to.

PROB.

PROB. I.

The Latitude of any Place being given, to rectify the Globe *for that Place.*

DEFINITION.

I Have already told you, that the latitude of any place is the ſame thing as the elevation of the pole above the Horizon; therefore, whatever the latitude be, ſuppoſe that of London 51° 32' N. or that of Madrid 40° 25' N. proceed thus:

Turn the pole on which the dial-plate is fixed towards the north part of the Horizon, ſlipping or moving the whole globe backwards or forwards, in the notches of the Horizon, till the Horizon cuts the Brazen Meridian, in 51° 32' (viz. a little more than 51½) ſo will the globe be rectified for the latitude of London; that is, the N. pole will then be elevated 51° 32' above the Horizon; and London being brought to the Meridian itſelf, will then be in the Zenith, or right up, and at an equal diſtance from all parts of the Horizon.

Depreſs the pole till the Horizon cuts the Brazen Meridian at 40° 25', and you will then have the poſition of the inhabitants at Madrid; and turning the globe, till Madrid comes to the Meridian, you will find it in the Zenith, or top of the globe, under 40° 25'.

Note. If it were required to rectify the globe for S. latitude, then you muſt elevate the S. pole to the given latitude inſtead of the N. pole; but this is better explained by the next problem.

PROB.

PROB. II.

The Latitude and Longitude of any Place being given, to find the ſame.

Firſt, YOU are to obſerve whether the longitude be reckoned from London, or from any other firſt Meridian; for on ſome globes the firſt Meridian begins at 23°, on others at 20°, and on Senex's globes at 18° W. from London; but, if once you know where the firſt Meridian is on the globe, it is very eaſy to know the difference between that and the Meridian of London, ſuppoſing it to begin from another place. As in moſt Engliſh authors the tables of longitude are counted from the Meridian of London, I here follow the ſame method.

See a farther account of longitude, DIALOGUE VII. Sect. I. Defin. 14.

EXAMPLE.

There are two certain places; one has 18° 00' N. latitude. and 77' 00' W. longitude. The other has 34° 29' S. latitude, and 18° 30' E. longitude from London; I demand what places theſe are?

RULE.

For the firſt place, I elevate the N. pole to 18° 00' becauſe it is 18° 00' N. latitude. Then I turn the globe to the right-hand, or eaſtward (becauſe the place lies weſtward) till 77° 00' upon the Equator, counted from the Meridian of London (which on Senex's globe has a cypher thus(o)on the Equator)paſſes through, or under the meridian; or, in other words, I turn the globe, till 77° 00' weſtward is brought under the meridian, and here I fix the globe with a quill thruſt in betwixt the globe and the Horizon; then I look under the latitude 18° 00' (which is in the Zenith) on the meridian on the top of the globe, and under 18° 00' on the meridian, I find Port Royal, or Kingſton, in Jamaica, the place required.*

For the ſecond place I elevate the S. pole (though there is no occaſion to elevate the pole barely to find a place; but it is better to do ſo, becauſe you have then the real ſituation of the inhabitants) to the given latitude 34° 29', and then turn the globe to the left-hand, or weſtward, till 18° 30' E. longitude from London come under the meridian. Then I look under the latitude 34° 29' on the meridian, and juſt under this I find the Cape of Good Hope, the place required.

Again, There are 3 places. The firſt 31° 55' N. latitude, and 35° 25' E. longitude: the ſecond is 39° 54' N. latitude and 116' 30' E. longitude: and the laſt is 7° 54' N. latitude, and 79° 00' E. longitude; I demand the places.

Anſwer, Jeruſalem, Pekin, and Candia, or Candy.

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* Kingſton being now conſidered as the capital of Jamaica, it is inſerted on moſt modern globes inſtead of Port Royal; but the difference of their ſituation is ſo trifling as not ſenſibly to affect the reſult of the Problem.

PROB.

PROB. III.

The Latitude of any Place being given, to tell all thoſe Places that have the ſame Latitude.

DEFINITION.

ALL thoſe places, that have the ſame latitude, have the days and nights of the ſame length, at the ſame time; but not the very ſame hour of the day. See Dialogue VI. Sect. IV. Defin. 2.

RULE.

Bring the given place to the meridian (ſuppoſe Madrid, in Spain, 40° 25' N.) then turn the globe, and all thoſe places that paſs under 40° 25', have the ſame latitude as Madrid; which you will find to be Pekin, in China, Samarcand, in Tartary, Naples, in Italy, and Philadelphia, in America, nearly; for a few minutes are not to be minded in ſuch caſes.

PROB. IV.

To tell the Difference of the Latitude of Places.

HERE are properly two queſtions, and conſequently two anſwers. Firſt, if the latitudes be both N. or both S. then ſubtract the leſs from the greater latitude, and the remainder is the difference or anſwer. Thus between London and Madrid is 11° 7', the firſt being 51° 32', and the other 40° 25'. And between Candy and Stockholm is 51° 26', for

Stockholm is about 59° 20' N. and Candy 7° 54' N.

Secondly, If one place lie on the N. and the other on the S. ſide of the Equator; that is, if one be in N. and the other in S. latitude, then add them both together, and their ſum is the difference of the latitude required.

Thus Copenhegen is 55° 41' N. and Botany-Bay 33° 50' S. theſe added together make 89° 31', the difference required.

PROB. V.

The Longitude of any Place being given from any Meridian, to tell thoſe Places that have the ſame Longitude.

THIS is done after the ſame manner as the other, only here the anſwer will be on the Equator, as the others were on the Meridian.

I would know what places have the ſame longitude as London, and the ſame longitude as Peterſburgh, in Ruſſia.

RULE.

Bring London to the Meridian, then all thoſe places on the Globe (from the N. pole to the S.) that lie under the edge of the Meridian, have the ſame longitude as London. Thus, Alenzon, in France, Valencia, in Spain, and Fort Naſſau, and Fort Mina, in Guinea, have the ſame, or very nearly the ſame longitude as London.

And Conſtantinople, in Turkey, and Alexandria, in Egypt, have very nearly the ſame longitude as Peterſburgh; alſo Scandaroon, Antioch, and Tripoli, in Syria, have the ſame longitude; viz. about 36° 30' E. from London.

PROB. VI.

To tell the Difference of the Longitude of Places.

(*See* Prob. XXVI.)

DEFINITION.

☞ *Note* 1. No place can exceed, or be above 180 d. of longitude from another place; for 181 d. E. longitude is more properly 179 d. W. longitude, for 181 d. taken from 360 d. there remains 179 d. which is nearer to the given place than 181 d.

RULE.

HERE alſo there are two queſtions, and conſequently two anſwers, as in Prob. IV. Firſt, If the places lie both E. or both W. of the firſt Meridian, or the line you reckon the longitude from; viz. if they both have E. or both W. longitude, then ſubtract one from the other, you have the difference.

Thus, I find Jeruſalem has 35° 25' E. longitude from London, and Pekin 116° 30' E. longitude; therefore I ſubtract 35° 25' from 116° 30' and there remains 81° 5' difference of longitude E. or W. that is, Pekin is 81° 5' E. longitude from Jeruſalem; or Jeruſalem is 81° 5' W. longitude from Pekin.

Secondly, If one place have E. and the other W. longitude from the firſt Meridian (ſuppoſe London, or any other Meridian) then add their longitudes together, and the ſum is the difference of longitude required.

EXAMPLE.

I would know the difference of longitude between Jeruſalem 35° 25' E. of London, and Port Royal in Jamaica 77° 00' W.

Here, as one is E. and the other W. I add 35° 25' and 77° 00' together, and their ſum makes 112° 25', the difference of longitude. That is, Jeruſalem is 112° 25' E. of Port Royal, or Port Royal is 112° 25' W. of Jeruſalem.

Note 2. If the difference of longitude after addition exceeds 180 d. take it out of 360 d. for that is the true longitude required. See *Note* 1.

EXAMPLE.

Pekin, in China, is 116° 30' E. longitude, and Port Royal is 77° 00' W. I add theſe ſums together, and find it 193° 30' difference of longitude; but, becauſe it is more than 180° I ſubtract 193° 30' from 360°, and there remains 166° 30', the difference required.

Tyro. Sir, I heartily thank you for this explanation, which I underſtand very well.

PROB. VII.

The Day of the Month being given, to find the Sun's Place in the Ecliptic.

RULE.

THE day of the month being given, look on the inner calendar on the new globes, and you have the ſign and degree of that ſign that the ſun is in on that day, according to the New Stile.

If it be upon old globes, look on the outward calendar, you have the ſign and the degree of the ſign.

N. B. You may further obſerve, that the calendar uſed throughout Europe is the calendar for N. S. viz. New Stile, and is always known from the other, becauſe it has the Saints Days, and ſeveral other things written upon it on the Horizon.

EXAMPLE.

I would know the ſun's place in the ecliptic, on May the 21ſt, N. S. March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt.

I look for theſe days of the months in order as they ſtand in the new calendar; viz. for N. S. before deſcribed, and right againſt the day of the month in the innermoſt circle on the Horizon, I find the ſun's place among the ſigns.

Thus, right againſt May the 21ſt, I find 1° of ♊ Gemini: and alſo on March the 21ſt, I find he enters ♈ Aries: on June the 21ſt, he enters ♋ Cancer: on September the 22d, he enters ♎ Libra: on December the 21ſt, he enters ♑ Capricorn.

☞ *Note,* That in every problem and operation, except Old Stile be mentioned, it is to be underſtood for New Stile; viz. N. S. and latitude always means N. latitude, except expreſſed S.

PROB.

PROB. VIII.

The Sun's Place being given, to find the Day of the Month.

RULE.

THIS is only the reverſe of the former problem: for having the ſun's place given, ſeek it in the innermoſt circle among the ſigns; then againſt that degree in the calendar N. S. you have the day of the month required.

EXAMPLE.

I would know what time of the year it is, viz. what month, and what day of the month it is when the ſun is in 1° of ♊, as alſo when he enters ♈, ♋, ♎, and ♑. Proceed according to the rule, and you will find the days to be May the 21ſt, March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt.

PROB. IX.

The Latitude and Day of the Month being given, to find the Sun's Place in the Ecliptic, and rectify the Globe for Uſe.

RULE.

FIND the ſun's place on the Horizon by Prob. VII. and having noted what degree he is in, look upon the ecliptic on the globe, and find the ſame ſign and degree as you did on the Horizon, then bring this degree of the ecliptic very carefully to the graduated edge of the Brazen Meridian, and holding the globe ſteady, turn the index exactly to the upper 12, which repreſents 12 at noon, and thus is the globe rectified for that day, and the degree of the ecliptic that lies under the Meridian, repreſents the ſun's place at noon, or 12 o'clock that day.

☞ The Aſtronomical day is reckoned from, or begins at, 12 o'clock at noon; and, if you fix the quadrant of altitude to the latitude in the Zenith, the globe will be completely rectified; but more of this by and by.

PROB. X.

To tell the Declination of the Sun on any Day of the Year.

DEFINITION.

Declination of the ſun is his variation from the Equator, either Northward or Southward.

N. B. His greateſt declination northward is 23 d. 30 m. which is on June the 21ſt, and his greateſt declination ſouthward is 23 d. 30 m. December the 21ſt: but on March the 21ſt, and September the 22d, when he enters ♈ and ♎, he has no declination at all, but is in the Equator itſelf; and then the days and nights are equal to all the inhabitants on the globe.

RULE.

Having found the ſun's place in the ecliptic for the given day, bring it to the Brazen Meridian,

ridian, and obſerve what degree of the meridian it lies under, and whether it be on the N. or on the S. ſide of the Equator, for that is the declination required, which is called N. or S. declination accordingly.

EXAMPLE.

Proceed according to the rule, you will find, on April the 21ſt, the ſun has 12° 00' N. declination, and on May the 21ſt, he has 20° 30' N. declination: but on October the 27th, he has 12° 50' S. declination, and on January the 30th, he has 18° S. declination nearly.

PROB. XI.

The Latitude and Day of the Month being given, to tell the Sun's Meridian Altitude; viz. *his Height at Noon.*

RULE.

BRING the ſun's place to the Meridian, and obſerve what degree of the Meridian the ſun's place is under; for thoſe degrees on the Meridian that are intercepted, or lie between the South verge of the Horizon, and the degree which is over the ſun's place on the Meridian, counted on the Meridian, is the ſun's Meridian Altitude required.

Note, The ſun's declination, when north, added to the complement of the latitude, will give the Meridian Altitude; but when ſouth ſubtract it therefrom, and the remainder will be the Meridian Altitude.

EXAMPLE.

I would know in the latitude 51° 30', on May the 21ſt, the ſun's Meridian Altitude, as alſo his Meridian Altitude on November the 5th. I proceed according to the rule, and find his Meridian Altitude, May the 21ſt, to be 59°; but on November the 5th, he has but 23° Altitude.

Proceed thus, and you will find his Meridian Altitude, in the latitude of 40° on the ſame days, to be 70°, and 34°: but in the latitude of 20°, on May 21, he will have 90° of altitude, or be right over head that day to the inhabitants in that latitude, which ſhall be further explained by and by.

PROB. XII.

The Latitude of the Place (ſuppoſe London) *and Sun's Meridian Altitude being given, to tell the Day of the Month ſuppoſing it were loſt.*

RULE.

THIS problem is the reverſe of the laſt; for you are only to ſet the globe to the latitude, then count from the S. verge of the Horizon, as many degrees on the Meridian upward as the given height is; then turn the globe till ſome point of the ecliptic comes under that degree of the Meridian, which will be the ſun's place that day, which ſeek in the circle of ſigns on the Horizon, and againſt it is the day required.

EXAMPLE.

In the latitude of 51° 30', on two certain days, I obſerved the ſun's Meridian Altitude to be 59° and 23° 30'; I demand what days they are?

Proceed according to the rule, you will find the one to be May 21, or July 24; the other November 3, or February 8. For it is to be obſerved, that the anſwer will be returned differently, according as you uſe the aſcending or deſcending ſigns; for every degree of the ecliptic has another correſponding to it in altitude, except the two tropical points of Cancer and Capricorn.

PROB. XIII.

The Latitude and Day of the Month being given, to tell the Sun's Altitude at any Time.

EXAMPLE.

ON May the 21ſt, at 9 in the morning, and at 5 in the afternoon at London, I would know the ſun's altitude.

RULE.

Rectify the globe for the latitude, and bring the ſun's place (1° ♊) to the meridian, and the index to the upper 12 on the dial-plate; then fix the quadrant of altitude in the Zenith; (viz. the left edge of the nut muſt be fixed on the meridian at 51° 30′) then turn the globe till the index points to the hour, viz. 9 in the morning; this done, fix the globe by thruſting in a quill between it and the Horizon; laſtly, turn the quadrant about, till the graduated or figured edge touch the ſun's place (viz. 1° ♊) and the degrees on the quadrant, counted from the Horizon upward on the quadrant, is his height at that time; viz. 43° 30'. Then turn the globe till the index points to 5 in the afternoon; and alſo turn the quadrant on the W. ſide (without unſcrewing it till it touches the ſun's place; and you have about 24° on the quadrant, his altitude at that time.

But at North Cape (viz. N. latitude 72°) at 9 in the morning May 21, he will be but about 32° high.

PROB. XIV.

The Latitude (ſuppoſe London) *and the Sun's Altitude and Day of the Month being given, to tell the Hour.*

THIS is but the reverſe of the laſt problem, only it will have two anſwers; viz. the hour may be either in the morning or afternoon.

RULE.

Rectify the globe as before directed, and turn the globe and the quadrant on the E. ſide, till the quadrant touches the ſun's place at the given height, (which by the laſt, on May 21, at 9 in the morning, was found 43° 30'), then look at the index, and it will point to the hour; turn it W. till the ſun's place touch the ſame degree on the quadrant on the W. ſide, and you will have the time in the afternoon.

EXAMPLE.

Thus on May the 21ſt, at London, when the ſun is 43° 30' high, it is either 9 in the morning, or three in the afternoon.

Note. When the ſun's place and quadrant are on the E. ſide of the meridian, it is morning hours; but when the ſun's place is on the W. part of the meridian, or weſtward of it, it is afternoon.

PROB. XV.

The Latitude being given, to tell the riſing and ſetting of the Sun, and the Length of the Day and Night, at any Time of the Year.

RULE.

RECTIFY the globe (viz. elevate it for the latitude, bring the ſun's place to the meridian, and index to the upper 12), then turn it till the ſun's place comes even with or lies againſt the inner verge on the E. ſide of the Horizon, then the index will ſhew you the time of the ſun's riſing; turn it to the W. ſide or verge of the Horizon, and the index will ſhew you the ſetting. Or the latter part of the problem may be ſolved thus: having got the hour the ſun riſes, count how many it wants of 12; for ſo many hours will it ſet after 12. Thus; if the index points to 4 in the morning at riſing, it will of courſe ſet at eight at night; if it points any day at half an hour paſt 7 at riſing, it will ſet at half an hour paſt 4; both being four hours and a half from 12 at noon.

Note 1. If you double the number of hours between ſun-riſing and 12 it will give you the length of the Day from ſun-riſing to ſetting.

time; viz. 43° 30'. Then turn the globe till the index points to 5 in the afternoon; and alſo turn the quadrant on the W. ſide (without unſcrewing it till it touches the ſun's place; and you have about 24° on the quadrant, his altitude at that time.

But at North Cape (viz. N. latitude 72°) at 9 in the morning May 21, he will be but about 32° high.

P R O B. XIV.

The Latitude (ſuppoſe London) *and the Sun's Altitude and Day of the Month being given, to tell the Hour.*

THIS is but the reverſe of the laſt problem, only it will have two anſwers; viz. the hour may be either in the morning or afternoon.

R U L E.

Rectify the globe as before directed, and turn the globe and the quadrant on the E. ſide, till the quadrant touches the ſun's place at the given height, (which by the laſt, on May 21, at 9 in the morning, was found 43° 30'), then look at the index, and it will point to the hour; turn it W. till the ſun's place touch the ſame degree on the quadrant on the W. ſide, and you will have the time in the afternoon.

E X A M P L E.

Thus on May the 21ſt, at London, when the ſun is 43° 30' high, it is either 9 in the morning, or three in the afternoon.

Note. When the ſun's place and quadrant are on the E. ſide of the meridian, it is morning hours; but when the ſun's place is on the W. part of the meridian, or weſtward of it, it is afternoon.

PROB. XV.

The Latitude being given, to tell the riſing and ſetting of the Sun, and the Length of the Day and Night, at any Time of the Year.

RULE.

RECTIFY the globe (viz. elevate it for the latitude, bring the ſun's place to the meridian, and index to the upper 12), then turn it till the ſun's place comes even with or lies againſt the inner verge on the E. ſide of the Horizon, then the index will ſhew you the time of the ſun's riſing; turn it to the W. ſide or verge of the Horizon, and the index will ſhew you the ſetting. Or the latter part of the problem may be ſolved thus: having got the hour the ſun riſes, count how many it wants of 12; for ſo many hours will it ſet after 12. Thus; if the index points to 4 in the morning at riſing, it will of courſe ſet at eight at night; if it points any day at half an hour paſt 7 at riſing, it will ſet at half an hour paſt 4; both being four hours and a half from 12 at noon.

Note 1. If you double the number of hours between ſun-riſing and 12 it will give you the length of the Day from ſun-riſing to ſetting.

Note 2. If you ſubtract the length of the Day from ſun-riſing to ſun ſetting, from 24, the remainder ſhews you the length of the night, twilight included. See Prob. XXV.

Proceed thus, and you will find the ſun, on May 26, at London, to riſe about 4 in the morning, and ſet at 8 at night. Now double what he wants of 12 at riſing, viz. 8 hours, and it gives the length of that day at London, viz. 16 hours.

But at Madrid, on the ſame day he riſes about ¾ paſt 4, and ſets ¼ paſt 7 at night. And at Stockholm, on the ſame day he riſes at about ¼ paſt 3, and conſequently the days are 17½ hours long there.

BIBLIOTHECA BODLEIANA

PROB. XVI.

To tell the Length of the longeſt and ſhorteſt Day at London, *Latitude* N. 51° 30' *and at* Stockholm, *Latitude* N. 59° 20'

RULE.

YOU proceed the ſame way in this as in the laſt problem, only inſtead of bringing 6° of ♊, as before, you now work with 1° of ♋, or rather 30 of ♊, for then the ſun enters Cancer on June 21, or longeſt day.

You will find him, therefore, riſe at London, June the 21ſt, at 48 m. paſt 3 in the morning, which wants 8 h. 12 m. of 12; this doubled gives 16 h. 24 m. for the longeſt day at London.

Then work with 1° of Capricorn, or rather 30° of Sagittarius, for the ſhorteſt day; viz.

bring 30° of Sagittarius to the meridian, and the index to 12, and you will find the ſun riſes 12 m. paſt 8, which wants 3 h. 48 m. of 12; this doubled gives 7 h. 36 m. the length of the ſhorteſt day.*

Proceed now for Stockholm (viz. 59° 20′ N. latitude) and if you work in the ſame manner, you will find the longeſt day to be about 18½ h. and the ſhorteſt 5½ h. And thus, for any other latitude, or place, not exceeding 66° 30′; for there the days will be 24 h. and, if you go to a greater latitude either N. or S. you will find them 30 h. long, or even 2, 3, 4, or 5 days, nay 2, 3, 4, or 5 weeks, or as many months, which I ſhall explain in a problem by itſelf hereafter.

Tyro. This is a little ſurpriſing, indeed, and at preſent I muſt own ſeems very ſtrange to me.

Philo. I aſſure you it is not more ſtrange than true, as you will plainly perceive when we come to treat of it.

PROB. XVII.

To tell the Sun's right Aſcenſion.

WHAT right aſcenſion is, you will find in Dial. VII. Sect. I. Art. 6.

Bring the ſun's place to the Brazen Meridian, and note what degree of the Equator is cut by the meridian, for that is his right aſcenſion required.

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* The length of days given above, is excluſive of Refraction; for if that be taken into the account, the longeſt day will be 16 h. 34 m. and the ſhorteſt 7 h. 44 m. but this would not correſpond with the operations of a globe.

EXAMPLE.

I would know the ſun's right aſcenſion, on March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt.

I find the ſun's place for theſe different days, and bringing it to the meridian, I find the meridian cuts the Equator in (0) in (90) in(180) and in (270°) his right aſcenſion required.

Note. When the ſun enters ♈, March the 21ſt, he has no right aſcenſion, becauſe it is counted from, or begins at ♈; therefore, on March the 20th, he muſt have his greateſt right aſcenſion, viz. 360°.

PROB. XVIII.

To find the Sun's oblique Aſcenſion and Deſcenſion at any Time, and in any Latitude.

See Oblique Aſcenſion and Deſcenſion, Dial. VII. Sect. I. Article 7, 8.

N. B. Though the latitude is not required in finding the right aſcenſion, becauſe the Equator will be cut in the ſame place by the meridian, whether the pole be elevated or depreſſed; yet in the oblique aſcenſion, the Horizon will cut the Equator in different degrees according to the latitude, as will appear from the work and your own reflection.

RULE.

1. RECTIFY the globe, and bring the ſun's place down to the eaſtern verge of the Horizon; then obſerve what degree the Horizon cuts the Equator in, for that is the oblique aſcenſion required.

2. Turn the globe till the ſun's place comes to, or lies level with the weſtern verge of the Horizon, and the degree of the Equator cut by the Horizon, is the oblique deſcenſion required.

Thus on March the 21ſt, June the 21ſt, September the 22d, and December the 21ſt; viz. when the ſun enters ♈, ♋, ♎, and ♑, you will find his oblique aſcenſion at London to be (0) (56) (180) and (304).

And on the ſame days his oblique deſcenſion will be (0) (123) (180) and (237½).

P R O B. XIX.

The Latitude and Day of the Month being given, to tell the Sun's aſcenſional Difference; viz. *how much he riſes or ſets before and after* 6; *and, conſequently, to tell the Length of the Days, ſuppoſing there were no Index to the Globe.*

R U L E.

BY Prob. XVII. and XVIII. find the ſun's right, and oblique aſcenſion; then ſubtract the oblique from the right aſcenſion, or the contrary, and the remainder is the aſcenſional difference required; which divide by 15, the degrees of the Equator that paſs through the meridian in 1 hour (or 7½ in ½ an hour) and the quotient gives the anſwer in time that the ſun riſes and ſets before and after 6. See an example in figures, how to convert degrees and minutes into time, Prob. XXVI.

EXAMPLE *for* LONDON.

On May the 26th, I find the ſun in 6° of ♊ and his right aſcenſion 64°, and on the ſame day his oblique aſcenſion is 34°; now 34° from 64° there remains 30°, his aſcenſional difference; which divide by 15, and the quotient gives two hours, the time that he riſes before, or ſets after 6.

This you may prove by Prob. XV. for you will find he riſes at 4, and ſets at 8, May the 26th.

But on December the 6th, his right aſcenſion is 256°, and his oblique aſcenſion is 286°, their difference is 30° which is two hours, that he riſes after, or ſets before, 6.

N. B. The right exceeds the oblique aſcenſion from ♈ to ♎, when the ſun riſes before 6; but the other half year that he riſes after, or ſets before, 6, the oblique exceeds the right aſcenſion.

PROB. XX.

The Latitude and Day of the Month being given, to find the Sun's Amplitude; viz. his Diſtance from the E. *or* W. *Point at his riſing and ſetting, and the Point of the Compaſs he riſes and ſets upon.*

RULE.

THE globe being rectified, bring the ſun's place to the eaſtern verge of the Horizon (which ſhews his riſing) then the degrees upon the innermoſt circle of the Horizon, counted from the true E. point to the place which the ſun's place lies againſt on the Horizon, ſhew you the ſun's amplitude.

EXAMPLE *at* LONDON.

Proceed according to the rule, and you will find the ſun's amplitude (May the 21ſt) at riſing to be about 34° from the Eaſt to the N. and at ſetting 34° from the W. to the N. and the point he riſes upon is N. E. by E. and he ſets N. W. by W. But on November the 5th, he has about 25° 30', amplitude from the E. to the S. and at ſetting 25° 30' from the W. to the S. The point he riſes upon is E. S. E. and the point he ſets upon is W. S. W.

PROB. XXI.

The Latitude, Day, and Hour being given, to find the Sun's Azimuth; *viz. his Diſtance from the* E. *and* W. *or from the* N. *and* S. *Points at any Time.*

See Azimuth, Dial. VII. Sect. I. Article 11.

RULE.

RECTIFY the globe, then turn it round till the index points to the given hour; this being done, turn the quadrant, till it touches the ſun's place for the given day; and then the quadrant will cut the Horizon in the Azimuth required from the E. or W. points, or from the N. or S. points, for you may reckon from either, only then name it properly and accordingly.

Thus on Auguſt the 17th, at 9 in the morning, the ſun will have about 30° Azimuth from the E. to the S. or, which is the ſame, 60° from the S. to the E. for 60° and 30° make 90° the whole quarter from E. to S.

N. B. Some authors call this 60° S. amplitude; but others call it 30° S. amplitude; that is, 30° from the E. to the S. as I ſaid before.

This will appear yet plainer, if we would know the Azimuth of the ſun the ſame day, at 11 in the morning, which is 68° 30ʹ from the E. to the S. or 21° 30ʹ from the S. to the E.

But on May the 21ſt, at 3 in the afternoon, he will have 25° Azimuth from the W. to the S. viz. 65° Azimuth from the S. to W. And at ¾ paſt 5, his Azimuth is 10° from the W. to the N. or 80° from the N. to the W.

Tyro. Sir, I underſtand the demonſtration quite well; but how am I to expreſs, or name, the Azimuth in general.

Philo. By the words North and South, becauſe it will always be either northward or ſouthward, reckoning from the E. and W. points either North or South.

Thus as before, Auguſt the 17th, at 9 in the morning, the ſun has 30° S. Azimuth (viz. from the E. point ſouthward) but on May the 21ſt, at ½ h. paſt 4 in the morning, he has 30° N. Azimuth; viz. 30° from the E. northward.

PROB.

PROB. XXII.

The Latitude and Azimuth being given on any Day, to tell the Hour, or Time of the Day.

RULE.

THIS is the reverſe of the former problem, for the globe being rectified, turn the quadrant of altitude to the given degree of Azimuth (from the E. or W. point on the Horizon) and there hold the quadrant ſteady with one hand, and with the other turn the globe, till the ſun's place for the given day touches the figured edge of the quadrant, and the index will point to the hour, or time, required.

EXAMPLE *for* LONDON,

On Auguſt the 17th, I obſerve the ſun's Azimuth to be 30° from the E. to the S. I would know the hour. Anſwer, 9 in the morning.

Again, on May the 21ſt, I find his Azimuth 10° from the W. to the N. what is the hour? Anſwer, ¾ paſt 5 in the afternoon.

PROB. XXIII.

The Latitude, Day, and Hour being given, to tell the Sun's Almacanther.

DEFINITION.

ALMACANTHERS are circles of altitude parellel to the Horizon, and whoſe poles are the Zenith and Nadir; ſo that you may imagine as many circles of altitude, viz. almacanthers, as you pleaſe.

RULE.

The almacanther is found the ſame way as the altitude of the ſun at any time; therefore, I refer you back to Prob. XIII.

PROB. XXIV.

The Latitude and Day being given, to tell what other Day of the Year will be of the ſame Length.

RULE.

HAVING found the ſun's place for the given day, bring it to the meridian, and obſerve well its declination; then turn the globe till ſome other degree of the ecliptic comes to the ſame degree of declination under the meridian; this being done, ſee what day of the month anſwers to the ſun's place then under the meridian, for that is the day required; which you may eaſily prove by Prob. XV.

I would know what day is of the ſame length as May the 26th, and of the ſame length as April the 17th. Anſwer, July the 16th, and Auguſt the 24th.

Note. Theſe laſt 8 Problems, as alſo Prob. IX. and X. are common to both globes; but are inſerted here, becauſe many perſons have a terreſtrial, that have not a celeſtial globe.

The following Problems more particularly concern, or belong to, the terreſtrial globe.

PROB. XXV.

The Latitude and Day of the Month being given, to tell the Beginning, Ending, and (conſequently) the Length, or Continuance, of Twilight.

DEFINITION.

TWILIGHT is that faint light which begins immediately after the ſun ſets in the evening, and continues till he is 18° below the Horizon; and begins in the morning, when the ſun comes within 18° of the Horizon on the E. ſide, and ends when he riſes.

Tyro. I have heard that this Problem is very difficult in compariſon of ſome others.

Philo. It is ſomething longer in its operation, but very eaſy, if you mind the rule and the operation together.

OBSERVATION.

As you were told that twilight begins and ends when the ſun is 18° below the Horizon, and as the quadrant of altitude reaches no farther than the Horizon, therefore the rule is this.

RULE.

The globe being rectified, &c. bring the degree directly oppoſite to the ſun's place to the quadrant of altitude, ſo that it touches juſt

18° on the quadrant, (then it is plain that the ſun's real place will be depreſſed 18° below the Horizon) then look on the index of the horary circle, for that will point (if among the morning hours) to the beginning, or (if among the evening hours) to the ending of twilight.

Note 1. What I mean by the degree oppoſite to the ſun's place, is this; it is that degree of the ecliptic, oppoſite to, or 180° from the given place of the ſun. Thus, ſuppoſe the ſun were in ♈, then I bring its oppoſite ſign (viz. ♎) to 18° on the quadrant, ſo will ♈ be depreſſed 18°, and the index will ſhew the hour.

Tyro. Sir, I now underſtand it very clearly.

Philo. Proceed then according to the rule, and you will find that on March the 21ſt, and September the 22d, twilight begins about 4 in the morning, and ends about 8 at night.

The ſun on theſe days, you know, riſes and ſets at 6. Add, therefore, the length of morning and evening twilight to 12 hours (the length of the days then) and it gives 16 hours; this ſubtracted from 24 hours, leaves 8 hours, the length of the real, or dark, night.

So alſo on April the 24th, twilight begins about ½ paſt 2, ends about ½ paſt 9, and laſts in all 4 h. 40 m. But on December the 20th, it begins nearly at 6, and ends at 6, and laſts in all 4 h. 14 m.

Note 2. There is no real night at London (but twilight from May the 22d, to July the 22d, the ſun all that time being leſs than 18° below the Horizon.

PROB. XXVI.

The Hour where you are being given, to tell what Hour it is in any other Part of the World. See Prob. VI.

RULE.

BRING the given place to the meridian, and ſet the index at the given hour; then turn the globe till the other place, or places, come under the meridian, and the index will point to the real time in the place required.

EXAMPLE.

When it is 2 o'clock in the afternoon at London, I would know the time at Jeruſalem, and at Port Royal, or Kingſton, in Jamaica.

Proceed according to the rule, and you will find, that when it is 2 in the afternoon at London, it is 22 minutes paſt 4 at Jeruſalem; and but 52 minutes paſt 8 in the morning at Port Royal.

Another METHOD.

I told you in Prob. XIX. that 15° on the Equator make 1 hour of time; therefore this Problem may be ſolved by common diviſion, for having the difference of the longitude of any two places (taken from a map) divide it by 15, the quotient is the difference of hours; and if any degrees remain, allow 4 m. for every degree, and ſo in proportion for the odd minutes or miles.

Thus I find by Problem VI. Jeruſalem is 35° 25' E. longitude of London; I divide, therefore, 35° 25' by 15, and the quotient is 2 hours, and the remainder is 5°, 25', which is 5 times 4, or 20 m. and the odd 25 m. or miles, is nearly 2 m. ſo that the difference is 2 hours 22 m. and as Jeruſalem is eaſt of London, it has its hour before us, therefore it is 22 m. paſt 4 in the afternoon.

Again, Port Royal is 77° 00° W. of London; this converted into time as before is 5 h. 8 m. that Port Royal has its time later than London; for when it is noon at London, it wants 8 m. of 7 in the morning at Port Royal.

PROB. XXVII.

The Day of the Month being given, to tell thoſe Inhabitants that will have the Sun in their Zenith *(or over their Heads) on that Day.*

OBSERVATION.

THIS cannot happen to any other inhabitants, but thoſe in the Torrid Zone, that is, to ſuch as have not above 23° 30' of latitude, either N. or S.

RULE.

Bring the ſun's place to the meridian, and obſerve exactly his declination for that day; then turn the globe any way, and obſerve what places paſs under that degree of declination on the meridian; for all ſuch will have the ſun directly direɛtly over their heads ſome time or other on that day.

EXAMPLE.

I would know what inhabitants, or places, will have the ſun in their Zenith on May the 21ſt.

Proceed as direɛted by the rule, and you will find the city of Mexico, Campeachy, St. Jago in Cuba, Owhyhee, and many other places that will paſs under that degree of declination (viz. 20° N.) and will have the ſun in their Zenith on that day.

Alſo on April the 16th, the inhabitants of Porto Bello, Carthagena, Iſle of Trinidad, Cochin in India, the Philippine iſlands, and Sierra Leone, (the new Engliſh Settlement on the Weſt coaſt of Africa) will have the ſun that day in, or near their Zenith.

PROB. XXVIII.

The Day and Hour being given in any Place, to tell thoſe Inhabitants, or that Place, to which the Sun is then vertical; viz. in the Zenith.

RULE.

BRING the given place to the Brazen Meridian, and turn the index to the given hour; this done, turn the globe till the index points to the upper 12, or noon; then look under the degree of the ſun's declination on the globe for that day, for that is the very ſpot, or place, to which the ſun is then vertical.

EX-

EXAMPLE.

On May the 10th, at 8 m. paſt 5 in the afternoon, at London, I would know what place has the ſun then in its Zenith. Anſwer, Port Royal, in Jamaica.

N. B. There are two days in which the ſun is vertical to all the inhabitants of the Torrid Zone; which muſt be when the ſun has the ſame declination; and in this Problem the other day will be Auguſt 2; viz. the ſame declination as on May the 10th.

Thus alſo will you find that, when it is 33 m. paſt 6 in the morning at London, on April the 10th, and Auguſt the 31ſt, the inhabitants at Candy, in the iſland of Ceylon, will have the ſun then in their Zenith.

PROB. XXIX.

To tell the Diſtance of one Place from another in Degrees and Minutes (viz. *Miles*) *in an Arch of a great Circle**, *alſo their Bearing, or Situation, in reſpect of each other.*

RULE.

BRING one of the places to the meridian, and elevate the globe for the latitude of it, and fix the quadrant in the Zenith: then turn the globe till the quadrant touches the other place, and the degrees on the quadrant between place and place ſhew the diſtance; and the quadrant at the ſame time will cut the Horizon in the point of the compaſs, called the bearing, or ſituation, from the firſt place.*

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* *Note*, 60 miles, or minutes, are reckoned a degree in general; but this is a vulgar error; for it is proved that every degree on the earth's ſurface in every great circle (ſuch as the Equator, Meridian, &c.) is 69½ miles; therefore, multiply the degrees by 69½, you have the diſtance in Engliſh miles.

EXAMPLE.

I would know the diſtance from London to Port Royal, Jeruſalem, and Moſcow, as alſo their ſituation in reſpect of London.

Proceed according to the rule, and you will find from London

	Deg.		Miles.	
To Port Royal	68	viz. nearly	4726	W.
To Jeruſalem	32½		2259	E. S. E.
To Moſcow	22½		1564	E. N. E.

PROB. XXX.

The Latitude and Day being given, to tell what Time the Sun will be due E. or W.

Tyro. THIS is eaſy, I think; for as the ſun is always due N. and S. at 12 at night, and at 12 at noon, I ſuppoſe he will be due E. and W. at 6 in the morning, and 6 in the evening.

Philo. I thought you would ſtumble upon this general error; but you will ſoon ſee your miſtake.

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* The Bearing is here to be underſtood on the Arch of a great Circle, which is by an angle of Poſition, very different from a Bearing by the Compaſs.

RULE.

RULE.

Rectify the globe and quadrant as before directed; then turn the quadrant till it touches the E. or W. point of the Horizon; this done, turn the globe till the ſun's place for the given day comes to the edge of the quadrant (holding the quadrant to the E. or W. point) ſo will the index of the horary circle point to the hour of his being due E. or W. on that day.

Proceed thus, and you will find about 5 m. paſt 7 in the morning, on May the 21ſt at London, the ſun will be due E. and about 5 m. before 5 in the evening due W. On June the 21ſt, he will be due E. about 22 m. paſt 7 in the morning, &c. but on December the 21ſt, he is due E. about 45 m. paſt 4 in the morning, and due W. about 15 m. paſt 7 in the evening.

PROB. XXXI.

To find Antœci *to any Place.*

See Antœcians, Dialogue VI. Sect. IV. Article 1.

RULE.

BRING London (or the given place) to the meridian, and count from the Equator on the meridian ſouthward the ſame number of degrees of S. latitude, as London has N. (viz. 51° 32') and cloſe to the edge of the meridian make a dot, for that is the place of the Antœci to London.

PROB.

PROB. XXXII.

To find the Pericœci *to* London, *or any other Place.*

See Definition of Pericœcians, Dial. VI. Sect. IV. Article 2.

RULE.

BRING London to the meridian, and turn the globe till 180° of the Equator paſs from London under the meridian; then under the ſame Latitude as London (viz. under 51° 32′ N.) at the edge of the Brazen Meridian make a dot, for that is the place of the Pericœcians required.

PROB. XXXIII.

To find the Antipodes *to* London, *or any other Place.*

See Definition of Antipodes, Dial. VI. Sect. IV. Article 3.

RULE.

BRING London to the meridian, and turn the globe till 180° paſs through the meridian, then count 51° 32′ ſouthward on the meridian, and under it make a dot, for that is the place of the Antipodes.

Or rather thus:

Bring London to the meridian, then ſlip the globe in the notches of the Horizon; viz. depreſs the pole, till London lies at the N. verge of the Horizon, juſt at the edge of the meridian;

dian; then at the S. point of the Horizon, cloſe to the meridian, make a dot, for that is the place of the Antipodes to London, which you will find to be in the Great South Sea, 51° 32′ S. latitude, and 180° longitude, near New Zealand.

PROB. XXXIV.

The Time of an Eclipſe of the Sun or Moon being given, to find all thoſe Countries, or Parts of the Globe, in which it will be viſible.

RULE.

1. FOR the Sun:—Find the place to which the Sun is vertical at the time of the eclipſe, by Problem XXVIII, elevate the Globe for the latitude of that place, and bring it to the Zenith or top of the Globe; then to all places in the upper hemiſphere, if the eclipſe be large, part of the Sun will appear viſibly obſcured; but if the eclipſe be ſmall, in places near the horizon, it will be inviſible on account of parallax.

2. For the Moon:—Find the place to which the Sun is vertical at the time of the eclipſe, as before directed; then find the Antipodes to that place, viz. the point exactly oppoſite thereto, (which will be the place of the Moon at that time) bring this point to the Zenith; then to all the inhabitants of the upper hemiſphere, the eclipſe will be viſible; to thoſe of the lower one inviſible.

EX-

EXAMPLE. 1

Sept. 5, 1793, the Sun was eclipſed at eleven in the morning;—Query, in what parts of the globe was the eclipſe viſible?

Proceed according to the rule, and you will find the Sun vertical to a part of the Coaſt of Guinea, in Africa, a little North Eaſt of Calabar; which point being brought to the Zenith, Europe, Africa, part of Aſia, and of North and South America, will appear in the upper hemiſphere, and in each of theſe the eclipſe was viſible, but more particularly in Africa. The Sun was nearly vertical to *Sierra Leone* at the end of the eclipſe.

EXAMPLE. 2.

Feb. 14, 1794, there was a total, and almoſt central, eclipſe of the Moon, at ten o'clock at night; on what parts of the globe might it be ſeen?

Proceed as before directed, and you will find the Sun vertical to a part of the South Sea, a little North of Otaheite and the Society Iſles, the oppoſite point to which (viz. the place of the Moon at that time) will be found in Africa, near the ſource of the river Nile; which point being brought to the Zenith, Europe, Africa, great part of Aſia, and Brazil in South America will appear above the Horizon, and in all theſe the eclipſe was viſible.

Note, The time given in each of the foregoing examples is that of the middle of the eclipſe (it being then more extenſively conſpicuous) but to find all the places at which any eclipſe will be viſible, the ſame operation muſt be repeated for the beginning and end, finding the place where the ſun is vertical, &c. at each time.

PROB.

PROB. XXXV.

The longeſt Day in any Latitude being given (ſuppoſe London 16½ *Hours) to tell in what other Latitude the longeſt Day is* 1, 2, 3, &c. *Hours longer than in the given Place.*

RULE.

RECTIFY the globe for the given latitude (viz. London) and bring the Solſtitial colure (viz. ♋) to the meridian; then where the Horizon cuts the tropic of ♋ make a dot on the tropic at the verge of the Horizon: this done, turn the globe weſtward, till 7° 30' of the Equator paſs under the meridian, and then make a ſecond dot on the tropic againſt the Horizon as before; then turn the globe back to its firſt poſition (viz. to ♋) and then elevate the pole, till the 2d dot appears at the edge of the Horizon, and the Horizon will cut the meridian in the latitude required.

Proceed as above, and you will find that in the latitude of 56° 20', the days are 1 hour longer than at London, which you may eaſily prove by Prob. XVI.

2. If you want to know the latitude where the day is two hours longer than at London, proceed as before, only inſtead of cauſing 7° 30' to paſs under the meridian, you muſt now turn the globe till 15° paſs under the meridian, and make then a dot on the tropic, as before.

3. If you want for 3 hours longer, make 22° 30' paſs through the meridian, and proceed

as before; and thus for every hour, cauſe 7° 30' more to paſs under the meridian.

Note, If you want to know the latitude where the longeſt day is an hour ſhorter than at London, only turn the globe eaſtward, inſtead of weſtward, till 7° 30' paſs through the meridian and make a dot on the tropic, and depreſs the pole till this lies even with the Horizon, you will find the latitude about 45° 30'. Thus for two hours longer about 60°, for 4 hours about 64° 20'; but for 2 hours ſhorter the latitude is about 35° 30'. This problem ſhews you the difference of climates.

PROB. XXXVI.

Any Time not exceeding ſix Months given, to tell that Latitude, or thoſe Places, where the Sun will not ſet for all that Time.

Note, That 28 days are here reckoned to the month. Bring the given time into days, and take the half of the number of days; but remember to abate 1 if the half exceeds 36. Then count from Cancer on the ecliptic the ſame number of degees as the half amounted to, and where this reckoning ends make a dot on the ecliptic. Laſtly, Bring this dot to the meridian, and as many degrees as are intercepted, or lie, between the dot and the pole itſelf, counted on the meridian, is the latitude required.

EXAMPLE.

I Demand the place, or latitude, where the ſun does not ſet for the ſpace of 4 months and 16 days.

This is 128 days, the half is 64°, abate 1° and it is 63°; this I count from ♋ on the ecliptic, and make a dot, and bringing it to the meridian, I find there are nearly 80° between the dot and the pole; viz. the latitude is 80°, which is at Smith's Inlet, the upper part of Greenland.

So alſo in the latitude of 85°, he ſets not for 5 months and 2 weeks. And in the latitude of 86° 30′ not for 5 months, 3 weeks, and 3 days; and in the latitude of 90°, not for 6 months; viz. from March the 21ſt to September the 22d.

Tyro. This appears, now, very plain to me, but I know the generality of perſons believe it to be falſe, for want of conſideration.

Philo. You ſee it is evident, for under the pole, in the latitude of 90°, when the ſun enters ♈ he begins to riſe, and does not ſet with the inhabitants there (If there be any) till he enters ♎; viz. for 6 months.

Tyro. I ſee it, Sir, very clearly; but, pray, have they not alſo a great ſhare of twilight? And are not the inhabitants at the contrary pole in darkneſs for a long time?

Philo. Yes, and ſo are the inhabitants in the N. part, when the ſun is in the tropic of ♑. This is plainly demonſtrated by the next Problem.

PROB.

PROB. XXXVII.

To tell in the Latitude 90 (where the longeſt Day is ſix Months) how long it continues to be Twilight after Sun-ſet; and how long their Night is after Twilight ends, before it begins again.

RULE.

YOU remember, according to the laſt Problem, the ſun ſets with the inhabitants at the N. pole, and riſes to thoſe of the S. pole, on September the 22d: conſequently twilight begins with thoſe at the N. pole on September the 22d. Therefore,

RULE.

1. Elevate the N. pole to the Zenith, and turn the globe, till ſome degree of the ſun's place in the ecliptic lies under 18° of the meridian, on the S. ſide of the Horizon, and you will find it 22° ♏; viz. November the 14th, the ending of twilight, that is, they have twilight from September the 22d, to November the 14th, and then they begin to have dark night (ſave the advantage of the moon) till the 28th of January. For,

2. Turn the globe till ſome other point of the ecliptic comes under 18° as before, and you will find it about 8° of ♒, which anſwers to the 28th of January, the beginning of twilight to the inhabitants of the N. pole, and on March the 21ſt, the ſun riſes with them.

Thus it appears, that the length of their day (from ſun-riſing to ſun-ſetting) is from March the 21ſt, to September the 22d, viz. 185 days.* The length, or continuance, of twilight, is from September the 22d, to November the 14th, and from January the 28th, to March the 21ſt, in all about 105 days; and their real night is from November the 14th, to January the 28th, viz. about 75 days.

Note, the ſame holds good (nearly) as to the inhabitants of the S. pole; for the ſun riſes with them when he enters ♎, and ſets with them when he comes to ♈.

Tyro. I perceive it plainly, Sir, and thank you for this clear demonſtration.

Philo. Now, *Tyro*, I ſhall ſhew you the uſe of the celeſtial globe; and after that give you ſome Problems, with the practical uſe of both globes.

Here follow ſome Problems on the celeſtial globe.

PROB. XXXVIII.

The day of the Month being given, to find the Sun's Place in the Ecliptic.

See Problem VII.

PROB. XXXIX.

This is the reverſe of the laſt, and done the ſame way as Prob. VIII.

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* It is an eſtabliſhed maxim with many geographers, that all parts of the globe equally enjoy the benefit of the ſun, in reſpect of time, and are equally deprived of it; but from hence it evidently appears that the North Pole is five of our days, every year, longer in the illuminated hemiſphere than the South Pole.

PROB.

PROB. XL.

To find the Declination of the Sun on any Day of the Year.

The ſame as Prob. X.

PROB. XLI.

To find the Sun's right Aſcenſion.

See Prob. XVII.

PROP. XLII.

To tell the Sun's oblique Aſcenſion and Deſcenſion in any Latitude, and on any Day.

The ſame as Prob. XVIII.

PROB. XLIII.

The Latitude and Day being given, to find the Sun's aſcenſional Difference.

The ſame as Prob. XIX.

PROB. XLIV.

The Latitude and Day of the Month being given, to tell the Sun's Amplitude; viz. *his Diſtance from the* E. *and* W. *Points at riſing and ſetting.*

The ſame as Prob. XX.

PROB. XLV.

The Latitude and Day being given, to tell the Sun's Azimuth.

The ſame as Prob. XXI.

PROB. XLVI.

The Latitude, Azimuth, *and Day being given, to tell the Hour of the Day.*

See the rule, Prob. XXII.

PROB. XLVII.

The Latitude, Day, and Hour being given, to tell the Sun's Almacanther.

See the rule, Prob. XXIII.

PROB. XLVIII.

To find the right Aſcenſion of any Star.

RULE.

BRING the ſtar to the meridian, and the degree of the equinoctial, cut by the meridian, is the right aſcenſion required.

Thus you will find the right aſcenſion of Aldebaran in Taurus to be about 66°, Arcturus in Bootes about 211° 34', Regel in Orion about 76° 8', and Sirius, or the Dog-ſtar, about 99°, &c. &c.

PROB. XLIX.

The Latitude being given, to tell the oblique Aſcenſion and Deſcenſion of any Star.

RULE.

RECTIFY the globe, and bring the ſtar to the eaſtern verge of the Horizon, and the degree of the equinoctial, that is then cut by the Horizon, is the oblique aſcenſion required. Turn the ſtar to the weſtern ſide, and the degree of the equinoctial, cut by the Horizon at the ſetting of a ſtar, is the oblique deſcenſion required.

Proceed thus, and you will find the oblique aſcenſion of Regel to be about 86° 54'; of Marhal in Pegaſus, about 325° 13'; and of Aldebaran, or the Bull's Eye, about 44° 45'. Turn each of theſe to the weſtern ſide, you will find their oblique deſcenſion 65° 22', 2° nearly, and 87° 15'.

Note, There is this difference between the right and the oblique aſcenſion and deſcenſion of the ſun and ſtars, that the ſun's oblique aſcenſion, &c. differ every day in the ſame latitude: but the ſtars oblique aſcenſion is every day the ſame.

PROB. L.

To tell the Declination of the Stars.

RULE.

As for the ſun's place, ſo alſo here, bring the given ſtar to the Brazen Meridian, and obſerve what degree of the Meridian lies right over the ſtar, for that is the declination either N. or S. according to which ſide of the equinoctial it lies on.

Thus you will find the declination of Aldebaran to be about 16° 5' N. The upper Pointer to the pole (in Urſa Major) about 62° 18', and the lower one 56° 55', but Regel in Orion

I find about 8° 27' S. and Cor Scorpionis about 26° S. declination, &c. &c.

From this Problem and the XLVIIIth ariſeth

PROB. LI.

The right Aſcenſion and Declination of any ſtar being given, to find the Star at once.

BRING the given degree of right aſcenſion on the equinoctial to the Brazen Meridian, then look under the degree of declination on the Meridian, and you will find the ſtar at the Meridian, under the given degree of declination.

Thus, ſuppoſe I wanted to find Aldebaran, whoſe right aſcenſion is 66°, and his declination 16° 5' N. I firſt bring 66° of the equinoctial to the Meridian; and looking under 16° 5' N. declination on the Meridian, I find Aldebaran.

So alſo Sirius has 99° right aſcenſion, and 16° 26' S. declination; therefore I bring 99° of the equinoctial to the Meridian, and looking under 16° 26' S. declination on the Meridian, I find Sirius juſt at the Meridian. The ſame for any other ſtar.

PROB. LII.

To tell the riſing and ſetting of the Stars, and the Point of the Compaſs any Star riſes or ſets upon in any Latitude, and on any Day of the Year.

RULE.

BRING the Sun's place to the Meridian, and rectify the globe; then turn the globe till the given ſtar comes to the eaſtern verge of the Horizon, and the index of the hour circle will point to the time of riſing, and the Horizon will ſhew the point it riſes upon: turn it to the Weſt, and the index will point to the time of ſetting, and the Horizon will ſhew you the point it ſets upon.

Proceed thus, and you will find that Aldebaran, on November the 5th, at London, riſes a little paſt 6 in the evening, and ſets about 9 in the morning. The point he riſes upon is E. N. E. and the point he ſets upon is W. N. W. But Regel in Orion, the ſame night, riſes a little before 9 at night, and ſets about half paſt 7 in the morning. The point of riſing is E. by S. and of ſetting W. by S.

Note, The ſtars riſe and ſet every day on the ſame point of the compaſs, though at different hours.

PROB. LIII.

To tell the Time; viz. *how many Hours any Star continues above the* Horizon, *from its riſing to its ſetting, in any Latitude.*

RULE.

RECTIFY the globe, then bring the ſtar to the eaſtern verge, and note the time of riſing; then turn the globe to the weſtern ſide, and the number of hours that the index paſſes over on the dial-plate tells you the continuance of that ſtar above the Horizon.

Thus, I find Aldebaran at London continues up from the time of his riſing on any day (but for example take December the 25th) about 15 hours, and Regal about 10½ hours.

At Stockholm Aldebaran continues up above 16 hours; but at Port Royal he continues up but about 12¾ hours.

PROB. LIV.

To tell the Diſtance of one Star from another, in Degrees and Minutes, in the Arch of a great Circle.

THIS Problem properly contains four queſtions, and therefore requires four anſwers.

1. If the ſtars lie under the ſame Meridian, but have different declinations, bring them to the Brazen Meridian, and the degrees intercepted between them, counted on the Meridian, is the diſtance required.

Thus, I find, the two pointers in the Great Bear to be about 5° 30' diſtant from each other; and Eridef and the Dolphin's Eye about 29° 30' diſtant.

2. If they have the ſame declination, but be under different meridians, bring the firſt (at pleaſure) to the Brazen Meridian, and note the degree cut by the Equator; then bring the other to the Meridian, and note how many degrees have paſſed through the Meridian, for theſe ſhew their diſtance required.

Thus, I find, the difference between Aſſengue and Caput Meduſæ to be about 122° 30'; for Aſſengue (38½ declination) being brought to the Meridian, cuts the Equator in 277° 30', viz. 82° 30' from ♈ weſtward; and Caput Meduſæ cuts 40° of the Equator eaſtward; their diſtance, therfore, is 112° 30'.

3. If the ſtars neither lie under the ſame Meridian, nor have the ſame declination, then bring either of them to the Meridian, and elevate the pole to the ſame height as the ſtar has declination (that is, the ſame as you elevate the terreſtrial globe to the latitude of a place) for then the ſtar will be in the Zenith; then fix the quadrant to the Zenith, over the given ſtar, and extend it to the other ſtar, and the degrees on the quadrant ſhew the diſtance required in a true arch of a great circle.

Note. Though the diſtance of the ſtars from each other is thus determined in degrees, yet you are not to ſuppoſe their diſtance is ſo many degrees to be converted into Engliſh miles; but it only means, that they appear ſo far diſtant under ſuch an angle.

Thus, I find the diſtance between Capella and Cor Hydræ to be about 79°, and between Aldebaran and Sirius about 46° 30', &c.

4. If the ſtars be at ſuch a diſtance from each other, that the quadrant will not reach them, then bring either of them to the Horizon, and elevate, or depreſs the pole, till the other lies alſo at the verge of the Horizon, and the degrees counted upon the Horizon, between ſtar and ſtar, is their diſtance in degrees.

Thus, between Aldebaran and Cor Scorpionis you will find about 170 degrees.

PROB. LV.

To tell what Stars will be on, or near the Meridian, at Noon and at Midnight.

First, for thoſe at noon.

BRING the ſun's place to the Meridian for the given day, and all thoſe ſtars that are then under the Meridian are ſuch as are full S. or N. at noon.

2. Turn the globe till the index points to 12 at night (viz. the lower 12) and all thoſe ſtars that are then under the Meridian are the ſtars required.

Thus, I find, on May the 27th, Aldebaran is on the Meridian at noon, and Cor Hydræ will be on the Meridian Auguſt the 7th at noon; but on February the 4th, Cor Hydræ will be full S. about midnight. For only turn Cor Hydræ under the Meridian, and the index will point to the lower 12; and the Meridian itſelf will cut the ecliptic in 16° of ♒; viz. February the 4th.

PROB. LVI.

The Latitude, Day of the Month, and Hour of the Night, being given, to find the Altitude and Azimuth of a given Star.

RULE.

RECTIFY the globe for the latitude, and day of the month, then ſet the hour index to the given hour, and move the quadrant of altitude to the given ſtar; its Azimuth will then appear on the Horizon, and its altitude on the edge of the quadrant.

EXAMPLE.

Thus at London the 11th of May, at 11 o'clock at night, I find the altitude of *Cor Leonis* to be 26° 50', and its Azimuth 76° 30' from the South towards the W. or nearly Weſt by South.

PROB. LVII.

The Latitude, Day of the Month, and Altitude of a Star, being given, to find the Hour of the Night.

RULE.

RECTIFY the globe for the given latitude, and day of the month, then turn the globe about in ſuch a manner that the ſtar may be upon the edge of the quadrant in the given degree of altitude, then will the index point to the hour of the night.

This is but the converſe of the former Problem, and therefore needs no example.

PROB. LVIII.

To tell what Stars never riſe, and thoſe that never ſet, at London.

RULE.

1. ONLY obſerve what ſtars have above 38° 30' N. declination; for all ſuch never ſet at London, but are always above the Horizon,

2. Obſerve alſo thoſe ſtars that have above 38° 30' S. declination, for thoſe never riſe, but are always under the Horizon at London.

Thus, the Pointers in the Great Bear, Arideſ in Cygnus, and many others, never ſet.

Alſo, Canobus in Argo Navis, and Pes Centauri, and many others, never riſe at London.

OBSERVATION.

1. From what you have been taught, *Tyro*, it is eaſy to conceive, that by the inhabitants under the North pole no ſouth ſtar can ever be ſeen, nor can the inhabitants at the South pole ever ſee one of the ſtars in the other hemiſphere. But,

2. The inhabitants under the Equator have a pleaſant ſight of all the ſtars from pole to pole; for they riſe and ſet with them at right angles; therefore, no ſtar can continue above 12 hours above their Horizon.

Tyro. Sir, you have highly obliged me, and I ſee now very plainly the different aſpect of the heavens in different places.

PROB. LIX.

To know at any Time of the Year (in the Latitude of London*) where to find any Star, or tell the Name of any Star when required.*

RULE.

RECTIFY the globe for the day, and turn it till the index points to the given hour, then by a quadrant take the height of the required ſtar; or, for want of it (in a common way of gueſſing) obſerve what part of the heavens it is in; viz. whether E. N. S. W. or the like, as alſo its height as near as you can gueſs: this being done, ſet the globe in due order for the day and hour, and you will find the ſame ſtar on the globe: and, by applying the quadrant, you will find the exact point of the compaſs, and the real height the ſtar then has, which, though not perhaps near to what you gueſſed them at, yet, if it be any noted ſtar, you may aſſure yourſelf are its real height and bearing, as there is no other ſtar of note near it about that height, and upon the ſame point.

EXAMPLE.

Walking on December 25, at 8 at night, I obſerved a bright ſtar (as near as I could gueſs) on the S. E. point, and about 48°

high; I would know what ſtar it is. Anſwer, Aldebaran. I rectify the globe, and turn the index to the hour, and then turn the quadrant to the given point of the compaſs, and looking about 48° high on the quadrant, I find Aldebaran to be the neareſt bright ſtar by the quadrant on that point and at that height; therefore, I conclude it is Aldebaran.

Alſo at ¾ paſt 10, the ſame night, I ſee two very bright ſtars, one on, or near the Meridian, about 30° high, and the other near the S. E. point, and about 35° high. I demand their names. Anſwer, Regel in Orion's Foot, and Procyon in Canicula.

PROB. LX.

To tell the Latitude and Longitude of the Stars.

FIRST, obſerve, whether the given ſtar be on the N. or S. ſide of the ecliptic; and if it be on the N. ſide, elevate the N. pole 66° 33', and turn the globe till ♋ and ♑ lie in the N. and S. points of the Horizon, that is, till the ecliptic be parallel or even with the Horizon; fix the quadrant in the Zenith: then, keeping the globe ſteady, turn the quadrant till the edge of it touches the centre of the ſtar, and that degree on the quadrant (viz. the altitude of the ſtar in the latitude 66° 30') is the latitude required, and the degree of the ecliptic, cut by the quadrant, reckoned from Aries (or rather reckoned among the ſigns, as it happens) is the longitude required.

Thus you will find Arcturus in Bootes to be about 30° 57' N. latitude, and 201° 20' longitude from ♈, or rather 21° 20' of ♎. Alſo, Alcair is about 29° 19' of N. latitude, and 28° 51' of longitude in ♑.

2. For any South Star.

Elevate the S. pole 66° 30', and fix the quadrant in the Zenith, and apply it to the ſtar, as before directed, you have the latitude and longitude required, Thus you will find Pes Centauri to have about 42° 28' of S. latitude, and 237° longitude from ♈, or rather 27° in ♏, and thus for any other ſtar. See Table IV. Dial. VII.

PROB. LXI.

The Latitude and Day of the Month being given (ſuppoſe December 25, *at nine at Night at* London), *to ſet the Globe ſo as to repreſent the Face of the Heavens at that Time, and ſhew your Acquaintance the Names and Poſitions of the moſt eminent fixed Stars.*

RULE.

RECTIFY the globe for the latitude, and bring the ſun's place to the Meridian, and the index to 12. Then turn the globe to the given hour, viz. 9 at night, and there fix it, ſo will every ſtar on the globe (if you ſet the globe

N.

N. and S.) correſpond with, or point to, the ſame ſtar in the Heavens.

Thus (at London) I find Capella E. by S. about 75° high: Caſtor and Pollux, the firſt about 40°, and the latter about 45° high, near the E. point. Procyon below them, to the left hand, 23° high, E. S. E. Sirius yet lower, to the left, S. E. about 10° high; Betelgeuze on the ſame point, and about 38° high; Regel, more ſouthward, about 26° high; Aldebaran, on the ſame point, much higher, viz. about 53° high; the Seven Stars, or Pleiades, S. nearly, about 62° high; Mencar, S. by W. 40° high; Arideſ, N. W. about 26° high, &c. &c. &c.

PROB. LXII.

To tell the Time of the achronical *riſing and ſetting of the Stars.*

DEFINITION.

1. THE achronical riſing of a ſtar is when the ſtar riſes juſt at ſun-ſet.

2. A ſtar is ſaid to ſet achronically, when it ſets with the ſun.

RULE.

Bring the ſun's place, for the given day, to the weſtern ſide of the Horizon, and all thoſe ſtars that are on, or near, the Eaſtern ſide of the Horizon, riſe achronically; and thoſe on the weſtern verge of the Horizon ſet achronically.

Thus I find on December the 6th, that Aldebaran riſes achronically, but it ſets achronically on May the 21ſt. Alſo Sirius riſes achronically on February the 4th, and ſets achronically on May the 14th.

PROB. LXIII.

To tell the coſmical *riſing and ſetting of the Stars in any Latitude.*

DEFINITION.

A Star is ſaid to riſe coſmically, when it riſes with the ſun.

2. A ſtar is ſaid to ſet coſmically, when it ſets at ſun-riſing.

RULE.

Rectify the globe, &c. and bring the ſun's place to the eaſtern ſide of the Horizon for the given day; then all thoſe ſtars cut by the eaſtern verge of the Horizon riſe coſmically. The globe ſtill remaining in the ſame poſition, look at the weſtern verge, or edge, of the Horizon, and all thoſe ſtars cut by it, or that are very near it, ſet on that day coſmically.

Thus I find that Arcturus, and 2 ſmall ſtars in Hercules's Thigh, riſe coſmically, September the 25th. Alſo two ſtars in Eridanus, Aſſengue in Lyra, &c. &c. ſet coſmically. Marhal in Pegaſus, is but juſt below the Horizon,

N. and S.) correſpond with, or point to, the ſame ſtar in the Heavens.

Thus (at London) I find Capella E. by S. about 75° high: Caſtor and Pollux, the firſt about 40°, and the latter about 45° high, near the E. point. Procyon below them, to the left hand, 23° high, E. S. E. Sirius yet lower, to the left, S. E. about 10° high; Betelgeuze on the ſame point, and about 38° high; Regel, more ſouthward, about 26° high; Aldebaran, on the ſame point, much higher, viz. about 53° high; the Seven Stars, or Pleiades, S. nearly, about 62° high; Mencar, S. by W. 40° high; Arideſ, N. W. about 26° high, &c. &c. &c.

PROB. LXII.

To tell the Time of the achronical *riſing and ſetting of the Stars.*

DEFINITION.

1. THE achronical riſing of a ſtar is when the ſtar riſes juſt at ſun-ſet.

2. A ſtar is ſaid to ſet achronically, when it ſets with the ſun.

RULE.

Bring the ſun's place, for the given day, to the weſtern ſide of the Horizon, and all thoſe ſtars that are on, or near, the Eaſtern ſide of the Horizon, riſe achronically; and thoſe on the weſtern verge of the Horizon ſet achronically.

Thus I find on December the 6th, that Aldebaran riſes achronically, but it ſets achronically on May the 21ſt. Alſo Sirius riſes achronically on February the 4th, and ſets achronically on May the 14th.

PROB. LXIII.

To tell the coſmical *riſing and ſetting of the Stars in any Latitude.*

DEFINITION.

A Star is ſaid to riſe coſmically, when it riſes with the ſun.

2. A ſtar is ſaid to ſet coſmically, when it ſets at ſun-riſing.

RULE.

Rectify the globe, &c. and bring the ſun's place to the eaſtern ſide of the Horizon for the given day; then all thoſe ſtars cut by the eaſtern verge of the Horizon riſe coſmically. The globe ſtill remaining in the ſame poſition, look at the weſtern verge, or edge, of the Horizon, and all thoſe ſtars cut by it, or that are very near it, ſet on that day coſmically.

Thus I find that Arcturus, and 2 ſmall ſtars in Hercules's Thigh, riſe coſmically, September the 25th. Alſo two ſtars in Eridanus, Aſſengue in Lyra, &c. &c. ſet coſmically. Marhal in Pegaſus, is but juſt below the Horizon,

zon, therefore may be ſaid to ſet nearly coſmical, as it will within a day or two.

For the coſmical ſetting.

Turn the globe till the ſtar comes to the weſtern ſide of the Horizon, and obſerve the degrees of the ecliptic, then cut by the eaſtern ſide of the Horizon, for that will anſwer to the day of the coſmical ſetting.

Thus Arcturus ſets coſmically June the 22d. Alſo Aldebaran ſets coſmically November the 25th.

PROB. LXIV.

To tell the heliacal *riſing, and ſetting of the Stars.*

DEFINITION.

1. HELIACAL riſing is when a ſtar, once immerſed in the ſun's beams, gets out of them, ſo as to be ſeen at the eaſtern verge of the Horizon, juſt before ſun-riſing.

2. Heliacal ſetting, is when a ſtar once out of the ſun's beams gets into them ſo as to become inviſible after ſun-ſet.

Note 1. This heliacal riſing and ſetting of the ſtars is different according to their different magnitudes. For,

Note 2. Stars of the firſt magnitude are ſeen at riſing and ſetting when the ſun is but 12° below the Horizon. Stars of the 2d magnitude are not perfectly ſeen, till the ſun is 13° below the Horizon. Thoſe of the 3d degree when he is 14°. Thoſe of the 4th degree of magnitude, when he is 15° below the Horizon. Thoſe of the 5th degree, when he is 16°. Thoſe of the 6th degree, when he is 17°; and the nebulous, or ſmall ones, not unleſs he is 18° below the Horizon; viz. about the beginning and ending of twilight.

To find the heliacal riſing, the rule is, rectify the globe, and bring the given ſtar to the eaſtern verge of the Horizon; then fix the globe, and turn the quadrant to the weſtern ſide, till 12° of the quadrant touches the ecliptic; this done, note the degree of the ecliptic, that is cut by 12° of the quadrant on the weſtern ſide (for then will the real place of the ſun be depreſſed 12° on the eaſtern ſide) and that degree ſought in the calendar gives the heliacal riſing. The heliacal ſetting is found in the ſame manner by turning the quadrant to the eaſtern ſide. Thus you will find Aldebaran riſes heliacally July the 4th, and ſets heliacally May the 5th.

And Sirius the Dog Star riſes heliacally about Auguſt the 26th,*

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* N. B. The ancient poets make frequent mention of the ſtars riſing and ſetting in theſe three ways, which, for that reaſon, are ſometimes called *poetical*. The ſame poets likewiſe, and other writers, uſed to reckon their Dies Caniculares, or Dog Days, from the heliacal riſing of Sirius; but they did not agree when they ended. Some reckoned them to continue 30 or 40, and others 50 days. However, in this they greed, that the weather was very hot and ſultry for 5 or 6 weeks after the riſing of Sirius. But as it was then, ſo it s now a moſt ridiculous whim: for Sirius does not now riſe elically till near September, though our almanack-makers (for

And now, *Tyro*, I will leave you a few queſtions for practice at your leiſure, in order to exerciſe you in the foregoing Problems.

PROB. LXV.

The Latitude and Day given (ſuppoſe at London, November *the 5th) to tell*

1. THE riſing and ſetting of the ſun, and the point he riſes and ſets upon.
2. His meridian altitude.
3. His altitude at any hour, ſuppoſe ten in the morning.
4. His right and oblique aſcenſion.
5. His aſcenſional difference.
6. His amplitude at riſing.
7. His Azimuth at 10 in the morning.
8. His Almacanter at the ſame time.
9. The time he is due E.*
10. The length of day and night.
11. The length of twilight.
12. The length of the real night.
13. The people to whom he will be vertical that day.

(for what reaſon I know not) continue to reckon the beginning of Dog Days from July the 30th. But, however, it is plain that Sirius can no ways be charged with bringing this ſultry weather; becauſe three or four thouſand years hence he will not riſe heliacally till November, and then, perhaps, will be charged with bringing as much cold as he has hitherto been accuſed of bringing heat.

* To find what time the Sun will be due eaſt when he is below the Horizon, find the time when his oppoſite place will be due weſt, and *vice verſa*.

14. The very place to which he will be vertical at 10 o'clock at night at London. Alſo,
15. To tell what time Aldebaran, or any other ſtar, will riſe and ſet that night.
16. To tell alſo what time any ſtar will be due E. or W. (ſuppoſe Aldebaran) what is its amplitude at riſing and ſetting, its Azimuth at 8 at night, and the time of its being full S. Alſo,
17. To tell what point of the compaſs the Pointers will then be on, and what time they will be on the meridian above and under the pole ſtar.

Tyro. You may depend, Sir, upon my trying to work theſe Problems the firſt opportunity.

Philo. Very well; ſince you delight in theſe things, I will not leave you yet, but will ſhew you ſome Problems relating to Navigation and ſpherical Triangles, &c.

SECT. II.

Containing ſome uſeful Problems *in Navigation.*

PROB. I.

The Sun's Declination and Hour, when he is due E. *being given, to find the Latitude,* viz. *the Elevation of the Pole.*

RULE.

RECTIFY the globe to the ſame latitude as the given number of degrees of declination, and fix the quadrant in the Zenith; then convert the hours that the ſun is due E. before, or after, 6 o'clock, into degrees, and count the ſame number of degrees on the Horizon, from the E. point ſouthwards, and bring the quadrant to that degree of the Horizon, ſo ſhall the degree on the quadrant that is cut by the Equator be the complement of latitude, which taken from 90°, gives the latitude itſelf, or height of the pole.

EXAMPLE.

Sailing May the 21ſt, I made an obſervation that the ſun was due E. about 7 minutes paſt 7 in the morning, and his declination 20° N. I demand what latitude I was in.

Proceed by the rule, you will find the latitude to be 51° 30′ nearly.

PROB. II.

Having the Sun's Azimuth *at* 6 *o'Clock, and Declination, to find the Latitude.*

RULE.

As many degrees as are contained in the Azimuth given, ſo much elevate the pole, and fix the quadrant in the Zenith, and bring ♈ to the meridian: this done, count on the quadrant upwards, the complement of the ſun's declination to 90°, and bring that degree to the Equator, then the degree of the Horizon, cut by the quadrant, will be the complement of latitude, counted from the E. point, or elſe from the W. as it may happen, and what this ſum wants of 90° is the latitude required; or otherwiſe, the degrees counted from the other two cardinal points, either N. or S. as it may happen, will give the latitude.

EXAMPLE.

I find the ſun's Azimuth, at ſix o'clock, to be 12 d. 46 m. and his declination 20 d. what is the latitude? Work according to the rule, and you will have the anſwer 38° 30′ complement, that is 51° 30′ latitude required.

PROB. III.

The. Sun's Amplitude and aſcenſional Difference being given, to find the Elevation of the Pole, and Sun's Declination.

RULE.

RAISE, or elevate the pole ſo many degrees as is the aſcenſional difference, fix the quadrant in the Zenith, bring ♈ to the meridian, then count on the quadrant upward the complement of amplitude, and move the quadrant, till the ſame number on the quadrant cuts the Equator: the quadrant will then cut the Horizon in the degree of the pole's elevation, and the Equator in the degree of declination.

EXAMPLE.

I made an obſervation, that the ſun's aſcenſional difference was 27° 30', and his amplitude 33° 38'; I demand the latitude and declination.

Proceed according to the rule, and you will find the latitude 51° 30', and the declination 20° 10'.

PROB. IV.

The Sun's Altitude E. *and his declination being given, to prove the Elevation of the Pole.*

RULE.

ELEVATE the pole to the complement of the ſun's altitude at E. and fix the quadrant in the Zenith, and bring ♈ to the Meridian, then note on the quadrant of altitude the degree of declination, and bringing the ſame to the Equator, obſerve what degree the quadrant cuts the Equator in; for its complement to 90° is the height of the pole.

EXAMPLE.

The ſun's declination being 20° 10' N. his altitude E. (at London) 26° 8', I would know whether the ſuppoſed latitude (51½) agrees herewith in operation?

Here I ſubtract 26° 8' from 90°, and there remains 63° 52' complement of altitude, and I elevate the pole accordingly, &c. Then I bring ♈ to the meridian, and cauſe 20° 10' on the quadrant to cut the Equator, and I find it 38° 30', the complement of latitude required; which ſubtracted from 90°, gives 51° 30', the real latitude of the place.

PROB. V.

The Sun's Declination and Amplitude being given, to find the height of the Pole.

RULE.

ELEVATE the pole to the complement of amplitude, and fix the quadrant in the Zenith, and bring ♈ to the meridian, then count the ſun's declination on the quadrant, and bring that degree to the Equator; and the degree of the Equator, cut by the quadrant, is the height of the Pole, or the latitude required.

EXAMPLE.

Suppoſe the Sun's amplitude 33° 38', and his declination 20° 10', what is the latitude?

Proceed according to the rule, and you will find it about 51° 30'.

Tyro. I heartily thank you, Sir,

Philo. There are many other queſtions relating to Navigation, which may be deduced from theſe, and performed on the globes; which you will find treated of by and by.

SECT. III.

Containing ſome practical Problems, relating to ſpherical Triangles, applied in ſome meaſure to Navigation, Dialling, &c. by which the Learner will ſee more of the Nature of the Doctrine of the Sphere, than he poſſibly can do by way of Plane.

Note 1. That every triangle has three ſides and three angles.

2. The Perpendicular (called alſo Cathetus) ſhall be here repreſented by, or placed on, the Brazen Meridian itſelf.

3. The baſe ſhall be placed in general upon the Equator.

4. The Hypothenuſe (or diagonal line) is repreſented by the quadrant fixed to the Zenith, and turned to the extremities of the Perpendicular and Baſe, which will form a complete right-angled triangle.

5. A right-angled triangle is ſuch as has one of the angles right, or that contains 90°. An acute angle is leſs than 90°, and an obtuſe angle is more than 90°, as you will ſee by Prob. V.

PROB. I.

In the right-angled ſpherical Triangle ABC, *let the Perpendicular* AB *be* 42° 30', *the Baſe* AC 60° 15'; *I demand the Hypothenuſe* BC.

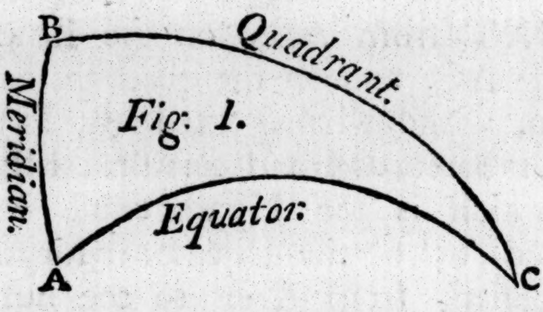


Fig. 1.

BRING ♈ to the Brazen Meridian, and there faſten the globe: then count from Aries 42° 30' on the Brazen Meridian, which is the perpendicular, and at 42° 30' fix the quadrant of altitude. Then count from Aries on the Equator 60° 15', which will repreſent the baſe; and note well the degree on the Equator, or elſe make a ſmall dot. This done, turn the quadrant till the figured edge of it touches the Equator at 60° 15'; and the degrees on the quadrant from the Equator to the Zenith will be the Hypothenuſe required, viz. about 68° 15'.

Note. It matters not in theſe ſort of Problems whethe you elevate the pole to the number of degrees of the perpendicular; for the anſwer will be the ſame whether you do ſo, or not.

Thus you will find alſo, when the Perpendicular is 55° 45', and the Baſe 70° 30', the Hypothenuſe will be 79° 30' nearly.

PROB. II.

The Baſe AC 60° 15', *and Hypothenuſe* BC 68° 15' *given, to find the Perpendicular* AB.

RULE.

COUNT from Aries on the Equator the baſe AC, and let the quadrant be on the Meridian, without being fixed faſt, ſo that you may ſlip it backward and forward, till 68° 15' of it (which is the Hypothenuſe BC) juſt touches 60° 15' on the Equator; for then will the Meridian, from Aries to the nut of the quadrant, tell you the perpendicular AB, viz. 42° 30'. See the figure. Alſo, let the baſe AC be 66° 30', and the Hypothenuſe BC be 75°, AB the perpendicular will be 49° 32'.

PROB. III.

The Perpendicular AB 42° 30', *Hypothenuſe* BC 68° 15' *given, to find the Baſe* AC.

RULE.

COUNT from Aries on the Meridian 42° 30' the perpendicular AB, and there fix the quadrant; then turn the quadrant till 68° 15', on the quadrant from the Zenith, touches the Equator, and the degrees on the Equator intercepted between the point Aries, and the quadrant, ſhew you the baſe AC; viz. 60° 15'. See the figure. Alſo, let the perpendicular AB be 35°, and the Hypothenuſe BC be 81° 30', AC the baſe will be 79° 36'.

Tyro. I underſtand the operations quite well.

Philo. I am glad of it; and it pleaſes me much to ſee you can apply things ſo well; for, you may obſerve, the Meridian cuts the Horizon, as well as the Equator, at right angles; therefore, by counting the Perpendicular from the Horizon on the Meridian, the quadrant will ſtill be the Hypothenuſe, and will cut the Horizon at the extremity, or degree, of the Baſe, as it did the Equator before.

From hence ariſe the following obſervations.

OBSERVATION I.

The N. and S. points of the Brazen Meridian being 180° diſtant, it is plain that the quadrant of altitude fixed in the Zenith, will (however extended) make two angles equal to 180°, or half the circle. For inſtance, if I lay the quadrant from the Zenith to the E. or W. points, I have then two right angles, each equal to 90°, viz. together equal to 180°; and if I move the quadrant from theſe points, ſuppoſe 30°, to the N. or the S. I ſtill have two angles made by the quadrant, the Meridian and Horizon equal to 180°: viz. one of them equal to 120°, and the other equal to 60°.

OBSERVATION II.

From hence then it plainly appears, that you may (by a little attention) find the length of any ſide, or the angle formed by any two ſides of a triangle; viz. whether it be an acute angle (viz. leſs than 90°) or an obtuſe angle (viz. more than 90°).

Tyro. I am ſtill more highly obliged to you, Sir, for this clear demonſtration

Philo. I ſhall then leave it wholly to your own conſideration and practice, as it is ſo plain and obvious, and proceed to an uſeful application of Prob. I.

PROB. IV.

A Ship ſails from N. *Latitude* 55° 45' *in a direct Courſe, till ſhe comes to the* Equator, *and her Difference of Longitude is* 76° 30' E. *from the Place whence ſhe departed: I demand the Rhumb in Navigation ſhe is then upon, and the Diſtance from the Place ſhe ſailed from, allowing* 60 *Miles to a Degree, and her diſtance in an Arch of a great Circle, viz.* 69½ *Miles to a Degree?*

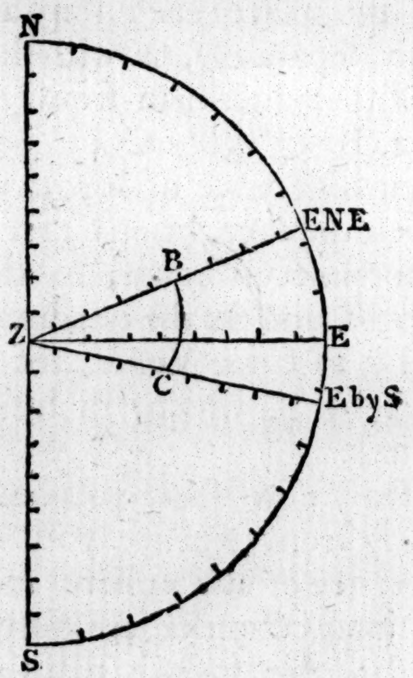
ANSWER.

THE rhumb the ſhip is upon is EbS. The diſtance from the place ſhe ſailed from is 82 degrees, that is, 4920 miles, at 60 to a degree, or 5699 miles, at 69½ to a degree.

PROB. V.

Two Ships, B *and* C, *ſet ſail from* Z, *in Latitude* 32° N. *and Longitude* 62° 30' W. *from* London. B *goes* ENE. 46° 30', *and* C *ſails* E. by S. 43° 30'; *I demand,*

1. *From whence they ſail,*
2. *The Places they arrive at.*
3. *The Rhumb, from the* N. *each Ship ſailed upon.*
4. *The Angle they make at ſetting out.*
5. *Their Difference of Longitude from the Place they ſet out.*
6. *Their Diſtance and Situtaion from each other.*



1. RECTIFY the globe to the given latitude and longitude, and Bermuda will be found to be the place they ſailed from.

2. Place the quadrant in the E. N. E. point, count from the Zenith on the quadrant 46° 30', which will give the place where the ſhip B is, viz. Gibraltar. Again, turn the quadrant to the E. by S. point, and count from the Zenith 43° 30', where you will find the place that the ſhip C arrived at, viz. Cape Verd.

3. Count the points from the N. and B will be found to have ſailed on rhumb 6, and C on rhumb 9.

4. The degrees on the Horizon from the E. N. E. to the E. by S. will ſhew the angle they made at ſetting out, viz. 33° 45'.

5. Bring the place each ſhip arrived at to the meridian ſeparately, it will ſhew you the difference of their meridian from the firſt ſetting out; viz. B. 57° 30', C 45° 30', both eaſtward. Their difference of longitude is 12°.

6. For their diſtance, bring either of the places arrived at, ſuppoſe Gibraltar, to the meridian, elevate the pole, and fix the quadrant in the Zenith; extend it to Cape Verde, and you will find it 24° S. W. by S. which, multiplied by 60, gives 1440 miles.

Philo. I ſhall now ſhew you how to make a common dial, from whence you will naturally ſee the properties of the ſphere more plainly, and by the interſection of the different circles, will yourſelf be able to riſe many curious and uſeful Problems.

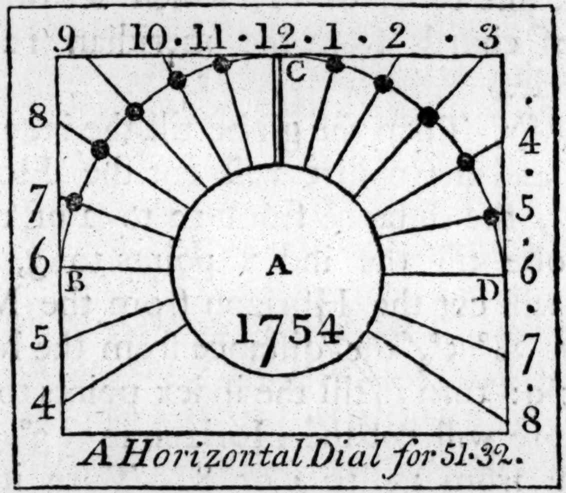
PROB. VI.

To make an horizontal Dial (viz. a Dial to be ſet upon a Poſt, or Pedeſtal) in any Latitude; but ſuppoſe for London.

EXAMPLE.

LET it be required to make an horizontal dial for the latitude of London.

Firſt, Take a piece of braſs, or a thick ſmoothe painted piece of board, of the ſame ſize as that of which you would have your dial;



A Horizontal Dial for 51·32.

and deſcribe upon it, a ſemicircle at pleaſure from the centre A, as B, C, D.

Secondly, Divide this ſemicircle into two equal parts by the line A 12.

Thirdly, Draw right lines by the extremity of the ſemicircle, ſo as to make them tangents to it at B, C, and D; theſe are to contain the hour lines; and thus is your plane, or dial-plate, ready to have the hours drawn from the centre.

Now

Now to find the diſtance from the meridian, or 12 o'clock line, in degrees and minutes.

RULE I. is,

Bring the vernal colure (viz. ♈) to the meridian, and the index to the upper 12; this done, turn the globe weſtward, till the index points to one o'clock; (or till 15 degree paſs through the meridian) and you will find the colure (viz. the line that paſſes through Aries from pole to pole) to cut the Horizon in 11° 50′ from the meridian, the diſtance from the 12 o'clock line to 1, or 11, which ſet off by any ſcale of chords from the meridian 12 on the ſemicircle.

Secondly, Turn the globe till the index points to 2, and the colure will cut the Horizon in 24° 15′, the diſtance from 12 to 2 or 10: turn the globe till the index points to 3, and the colure will cut the Horizon from the Meridian in about 38° 5′, the diſtance from the Meridian to 3 or 9: turn it till the index points to 4, and the colure will cut the Horizon in 53° 30′, the diſtance from 12 to 4 or 8. Turn it till the index points to 5, and the colure will cut the Horizon in 71° 4′, the diſtance from the Meridian, or 12 o'clock line, to 5 or to 7. The ſix o'clock line will be 90° from the Meridian, or 12 o'clock line, or will fall into the arch CD in the point D, viz. the colure will cut the Horizon at 90°, or in the eaſt point.

Thirdly, Take off theſe degrees and minutes from any ſector or ſcale of chords: and ſetting one foot of the compaſs in C, ſet off on the circle from C towards B and D 11° 50', 24° 15', &c. &c.

Fourthly, From the centre A draw lines through theſe dots or pricks, to the tangents or lines without the ſemicircle, and you have the true hour lines.

Note 1. The halves and quarters are found the ſame way, by turning the globe till the index points to ½ paſt 12; ½ paſt 1, &c. and obſerving in how many degrees the colure cuts the Horizon from the Meridian.

Note 2. After you have drawn the hours from 12 to 6 in the morning, and ſix in the evening, you may eaſily get the hours at 5 and 4 in the morning, by laying a ruler from the hours of 5 and 4 in the afternoon, and drawing lines through the centre. The ſame may be done on the other ſide of the plane, that is, lines drawn from 7 and 8 in the morning will be 7 and 8 at night.

Note 3. The ſtyle or gnomon of this dial makes an angle with the 12 o'clock hour line of 51° 32', and muſt be put in the centre A, and ſtand directly over the 12 o'clock line, or meridian of the plane.

☞ *Note*, Always remember to make an allowance for the thickneſs of the ſtyle or gnomon on the plane, by drawing two lines by the ſide of the Meridian line, as wide as the ſtyle is thick.

PROB. VII.

To make a direct S. *Dial, in the Latitude of* London.

There are two ways.

FIRST, let the globe remain for the latitude of London as before, and fix the quadrant in the Zenith, and turn it to the E. point, or to the W. and there fix it: then turn the globe to 11 o'clock or to one, and the colure will cut the quadrant in 9° 30'.

Turn it to 10 or 2, the colure will cut the quadrant in 19° 45', the diſtance from the Meridian.

Turn it to 9 or 3, it cuts the quadrant in 31° 53'.

Turn it to 8 and 4, it cuts in 47° 8'.

Turn it to 7 and 5, it cuts it in 66° 42'.

Or,

2. Elevate the pole to the complement of London's latitude to 90, viz. to 38½ (for 38½ and 51½ make 90) then turn the globe till the index points to 11 or 1, and the colure will cut the Horizon in 9° 30'; turn it to 10 or 2, the colure will cut the Horozon in 19° 45', &c. as before.

Tyro. Sir, I am extremely obliged to you; but if it were not too much trouble, I would take it as a favour if you would give me one example how to make a vertical dial that declines from the S. either eaſtward or weſtward; for you know that it is a chance indeed that a wall ſhould exactly face the ſouth.

Philo. I am ready to do every thing, *Tyro*, that lies within the compaſs of time, room, and ability. We will ſuppoſe then it were required as follows; viz.

PROB.

PROB. VIII.

To make an erect or vertical Dial, declining from the North towards the Eaſt or Weſt.

EXAMPLE.

Let it be a Dial declining from the N. *eaſtward* 60°.

RULE.

1. RECTIFY the globe, quadrant, colure, and index, as before.

2. Bring the qaudrant of altitude to cut the Horizon in the degree of declination; viz. 60° from the N. point, eaſtward, which repreſents a plane, declining that number of degrees.

3. Hold the quadrant faſt at 60°, and turn the globe eaſtward, till the index points to all the forenoon hours, and the colure will cut the quadrant in the number of degrees each hour is diſtant from the Meridian; and lines drawn through each of theſe from the centre, are the hours required.

Thus to find the forenoon hours.

I turn the globe till the index points to 11, 10, 9, &c. or till 15° of the Equator paſs through the Meridian, and I find the colure cuts the quadrant (from the Zenith) as follows:

		°	'
11	o'clock	9	30
10	——	18	15
9	——	26	12
8	——	35	5
7	——	45	10
6	——	57	20
5	——	76	00

The ſorenoon hours required, which will be on the W. or left-hand ſide of the 12 o'clock line, becauſe the plane declines eaſtward, and conſequently you have more hours in the forenoon than in the afternoon on this plane.

2. *To find the afternoon hours.*

I now turn the quadrant to the oppoſite point of the Horizon; viz. I cauſe it to touch 60° of the Horizon from the S. towards the W. and bring the index and colure back to the Meridian.

Then turning the globe weſtward, till the index points to 1, 2, 3, and 4, or till 15° paſs through the Meridian, the colure will cut the quadrant (counted from the Zenith) as follows:

For 1	o'clock	12°	45'
2	———	29	45
3	———	52	45
4	———	80	15

Theſe are the diſtances of the afternoon hours, from the 12 o'clock hour or meridian. Here you ſee the colure goes off the quadrant; therefore the ſun goes off this plane about 4.

3. *To find the diſtance of the Subſtyle, or place of the gnomon from the 12 o'clock line, as alſo the height of the ſtyle; do thus:*

Bring the colure to the Horizon in the plane's declination, counted from the S. towards the E. viz. bring the colure to 60° in the Horizon, counted from the S. eaſtward; and then turn the quadrant till that touches the ſame number of degrees (viz. 60°) from the N. eaſtward; ſo ſhall the quadrant and colure cut each other at right angles; and the number of degrees counted on the quadrant from the colure to the Zenith are the degrees of the ſubſtyle's diſtance, viz. 21° 40'; and the degrees from the pole to where the quadrant cuts the colure, counted on the colure, is the height of the ſtyle, viz. 32° 45'.

Laſtly, Meaſure or take off 21° 40' from any ſcale of chords, and ſetting one foot at the 12 o'clock line, turn the other weſtward, or to the left hand, and make a dot or prick; for right over this dot muſt the ſubſtyle or gnomon ſtand.

And thus by a little attention may any ſort of declining, inclining, or reclining dials be eaſily made by the globe. For a direct S. dial at London will be an horizontal dial to the inhabitants of 38° 28' S. latitude; viz. 90° diſtance from our Zenith,

So an erect plane under the pole is an horizontal one under the equator. An erect vertical at 80° N. latitude, will be an horizontal in 10° S. latitude, &c.

Tyro. Sir, I heartily thank you; for this gives me a clearer notion of the poſition of places and planes than I had before. But, pray, may not ſome problems relating to the moon be performed by the globes?

Philo. Yes; the very ſame way as thoſe relating to the ſun, when once you know her place in the ecliptic; but this you muſt find very often, becauſe it is continually changing, and indeed is ſo variable, that the operation will not ſtand long, or hold good but for that day only: but by getting her true place, you may tell her riſing, ſetting, and ſouthing, the hour of the night, the time of high water, &c.

I will give you a ſmall notion of it, and leave the reſt to exerciſe your own ingenuity. Divide the equinoctial into 30 equal parts, by red ſtrokes or figures, beginning at Aries, and at every 12th degree making a mark, as 1, 2, 3, 4, &c. this repreſents the 30 days of her age.

Now to find her place. Elevate the N. pole to the Zenith, and bring the equinoctial colure againſt the day of the month on the Horizon, viz. the day of new moon, ſo ſhall the moon's age (wrote in red figures) on the equinoctial, point to the degree of the Ecliptic, on the Horizon, ſhe is in, or near, at that time.

Tyro. I am extremely obliged to you, Sir, for all theſe favours; but, as neceſſity obliges me to go, I beg you would excuſe me, and receive my hearty thanks.

Philo. My dear pupil, I wiſh you well, and would adviſe you to employ your time in the practice of theſe things, rather than ſpend it in trifles and idleneſs.

Tyro. Sir, I thank you for your good advice,

Philo. Farewell.

A P-

APPENDIX:

CONTAINING

A ſhort Account of the Solar Syſtem, and
of the Comets, and fixed Stars.

DIALOGUE

Between PHILO, *a Tutor, and* TYRO, *a Pupil, concerning the* Solar Syſtem.

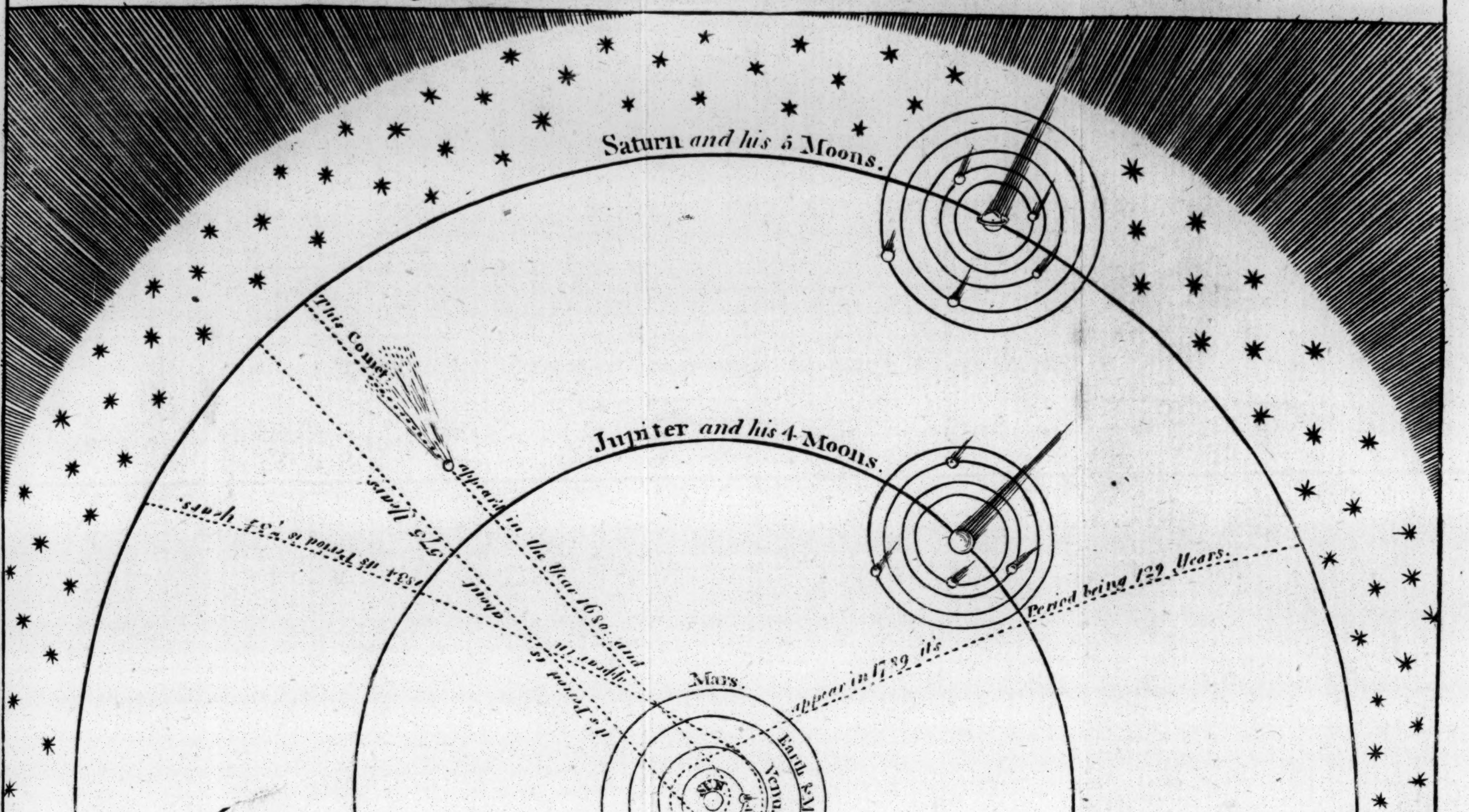
Tyro. THOUGH you have given me ſome notion of aſtronomy in the ſeveral problems you have ſolved relative to the ſun and ſtars, yet, as I have heard many things concerning the ſolar ſyſtem, and the comets and fixed ſtars, which I do not underſtand, I would take it as a particular favour if you would give me a more full and circumſtantial account of theſe heavenly bodies.

Philo. I will, my dear *Tyro*; but you muſt be content with a ſhort account indeed: for to give you a full account of all theſe particulars would greatly exceed the limits of this little Treatiſe, and ſtill more, the bounds to which I am confined in this ſhort Appendix. By the ſolar ſyſtem, then, you are to underſtand the ſun, which is placed in the centre, together with the ſix planets, Mercury, Venus, the Earth, Mars, Jupiter, and Saturn, which move round him. Theſe planets, with reſpect to their nearneſs to the ſun, are exactly in the order in which they are here mentioned. Mercury is neareſt to the ſun, Venus next, the Earth next, Mars next, Jupiter next, and Saturn is at the greateſt diſtance of all. The diſtances of the planets from the ſun may eaſily be conceived in the following manner: ſuppoſing the diſtance of the earth from the ſun to be divided into 10 equal parts, then that of Mercury will be four of theſe parts; that of Venus 7; that of Mars 15; that of Jupiter 52; and that of Saturn 95. Hence it appears, that the Earth is placed between Mars and Venus, having Mars, Jupiter, and Saturn above her, and Venus and Mercury below her; and for this reaſon it is, that the three firſt are called ſuperior, and the two laſt inferior planets. But to expreſs the diſtances of the planets from the ſun as nearly as poſſible, in Engliſh miles, the diſtance of Mercury from it is 36,841,468 miles; of Venus, 68,891,486 miles; of the Earth, 95,173,000 miles; of Mars, 145,014,148 m.; of Jupiter, 494,990,976 m. and of Saturn, 907,956,130 m. By theſe diſtances, however, are to be underſtood their mean diſtances; in order to comprehend which, it muſt be obſerved, that the orbit, or path,

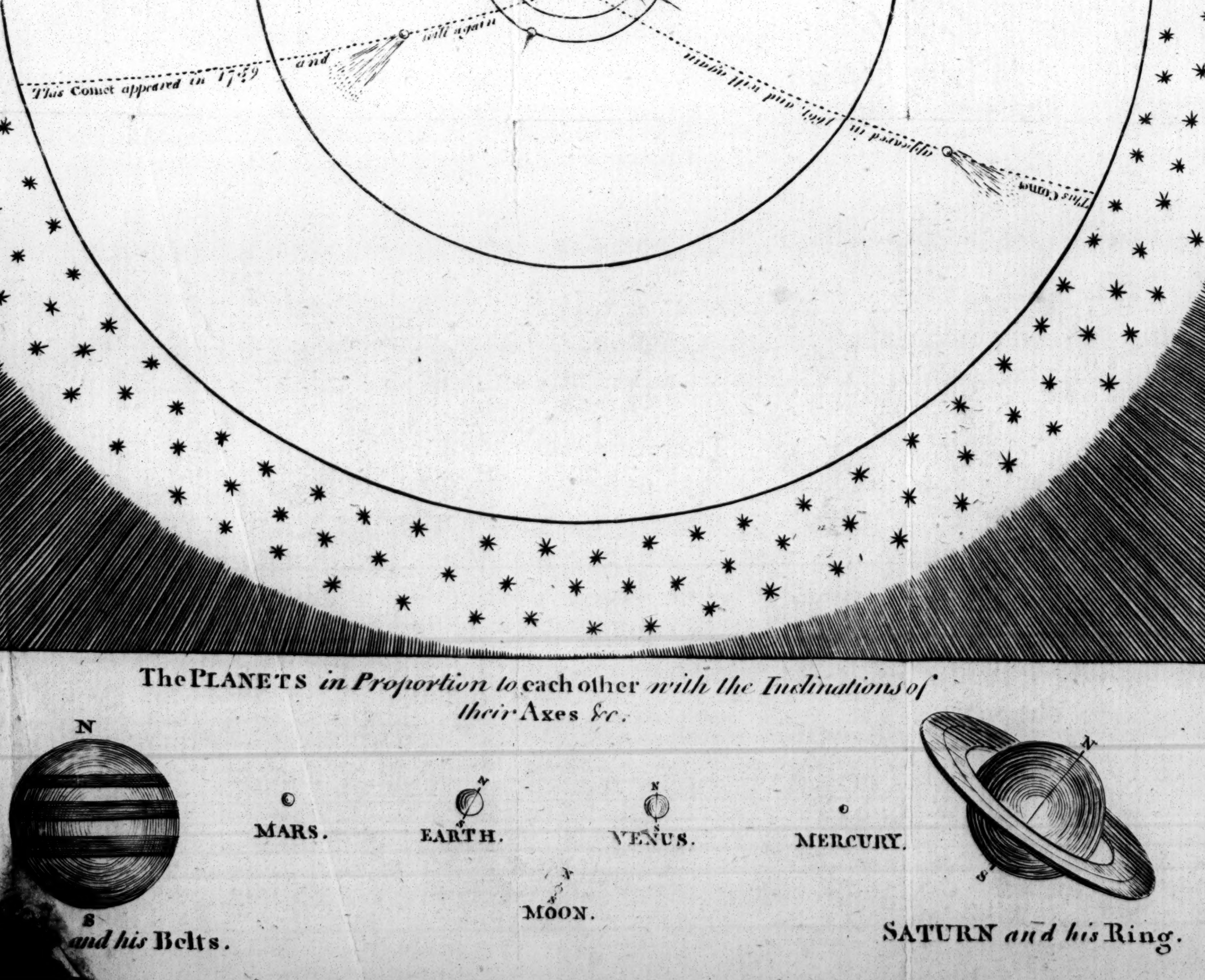
The COPERNICAN or TRUE SYSTEM of the UNIVERSE:

exhibiting the Orbits *of the* PLANETS *according to their mean* Distances *from the* SUN,

Engrav'd According to Act of Parliament for Mr. D. FENNING's. New Use of the Globes.


Saturn and his 5 Moons.
Jupiter and his 4 Moons.
Mars.
Earth & Moon
Venus
Mercury
SUN
This Comet appeared in the Year 1680 and
it's Period is about 575 Years.
appear in
1534 its Period is 127 Years.
This Comet appeared in 1759 and will again
appear in 1789 it's Period being 129 Years.
This Comet appeared in 1661 and will again

The PLANETS *in Proportion to* each other *with the Inclinations of their* Axes &c.



is about 10 inches in Diameter, according to the above Proportion of the Planets. —

which a planet deſcribes about the ſun, is not a perfect circle, but a figure called an ellipſis; which, though ſomewhat reſembling a circle, is longer than it is broad. Hence the ſame planet is not always at the ſame diſtance from the ſun, and the mean diſtance of it is that which is exactly between its greateſt and leaſt diſtance. The planets appear at firſt ſight like the fixed ſtars; but, upon a more accurate view, they may eaſily be diſtinguiſhed from them. 1. By their never twinkling, as theſe laſt do. 2. By their being ſeen earlieſt in the evening, and lateſt in the morning. And 3. By their changing their poſition with regard to the fixed ſtars, and to one another; but always keeping within the zodiac, that is, within 8 degrees of the ecliptic, either ſouth or north. Mercury is ſo near the ſun, that he can ſeldom be ſeen without the help of glaſſes. Venus is eaſily known, being ſometimes the evening, and ſometimes the morning ſtar; and Mars, Jupiter, and Saturn appear of a more red or fiery colour then the fixed ſtars.

Tyro. Do all theſe planets perform their revolution round the ſun in the ſame time?

Philo. No: that is not likely, conſidering their different diſtances from him. Mercury performs his revolution in about three months; Venus in about ſeven months and a half; the Earth in a year; Mars in about two years; Jupiter in twelve, and Saturn in about thirty years.

Tyro. Are all the planets of the ſame bulk or magnitude?

Philo. No: the Earth is 27 times as big as Mercury, very little bigger than Venus, 5 times as big as Mars; but Jupiter is 1049 times as big as the Earth, Saturn 586 times as big, excluſive of his ring; and the ſun is 877,650 times as big as the earth.

Tyro. You ſay the earth moves round the ſun. How can I believe that, when I plainly ſee, that the ſun moves round the earth?

Philo. You muſt naturally think ſo; but you are miſtaken; and your miſtake is eaſily accounted for from the following circumſtance, namely, that the appearance will be the ſame to you, whether the ſun moves round the earth, or the earth round the ſun. But firſt I muſt obſerve, that the earth has two motions; one round its own axis from weſt to eaſt, in twenty-four hours, which makes all the heavenly bodies appear to move round the earth from eaſt to weſt in the ſame time, and cauſes the regular ſucceſſion of day and night; and the other round the ſun in the ſpace of a year, which occaſions the change of the ſeaſons. That the appearance will be the ſame if the earth turns round its axis, as if all the heavenly bodies moved round the earth, may be eaſily proved by a very ſimple experiment. Go on board a ſhip, and let her be turned gently and uniformly round, you will not be ſenſible of the ſhip's motion, but will imagine that all the objects on land are moving round the ſhip. In like manner,

ner, let one ſhip be fixed immoveable in her ſtation; go on board another ſhip at the diſtance of two or three miles: let this ſecond ſhip ſail regularly and uniformly in a circular direction round the firſt ſhip; you will not be ſenſible of the motion of the ſhip in which you are, but will imagine that the immoveable ſhip is moving round you. The firſt of theſe is an exact repreſentation of the diurnal motion of the earth round its own axis; the ſecond, of its annual motion round the ſun.

Tyro. But though theſe motions of the earth be perfectly reconcileable to appearances, it does not therefore follow that they take place in fact.

Philo. That they do take place in fact, aſtronomers have proved by a variety of arguments, many of which are above your comprehenſion; and beſides, to mention them all, or even the principal of them, would greatly exceed the limits of this ſhort Appendix: I ſhall content myſelf at preſent with taking notice of one or two. In the firſt place, if the earth does not turn round its own axis, the ſun and ſtars muſt move round the earth in the ſpace of 24 hours. But conſidering the great diſtance of the ſun from us, if he was to go round the earth in 24 hours, he muſt travel upwards of 300,000 miles in a minute; and as the ſtars are at leaſt 400,000 times as far from the ſun as the ſun is from us, thoſe about the Equator muſt move 400,000 times as quick as the ſun. But this is a degree of velocity, which it exceeds the utmoſt ſtretch of human imagination to conceive; and indeed it ſeems to be as impoſſible to form any idea of it, as of infinite ſpace, or eternal duration. It is, therefore, natural to conclude, that the earth turns round its axis, which is eaſily conceived, inſtead of the ſun and ſtars moving round the earth, which it is impoſſible to comprehend.

In the next place, it is an eſtabliſhed law of nature, that a heavy body never moves round a light one as its centre of motion. A pebble, faſtened to a mill-ſtone by a ſtring, may by an eaſy impulſe be made to circulate round the mill-ſtone; but no impulſe can make a mill-ſtone circulate round a looſe pebble, for the heavieſt would undoubtedly carry the lighteſt along with it wherever it goes. But the ſun is at leaſt 227 thouſand times as heavy as the earth; and therefore, inſtead of the ſun moving round the earth, not only the earth, but all the other planets, muſt move round the ſun as their centre of motion. Beſides, if the ſun moved round the earth, it would take no leſs than 173,510 days to perform its revolution, and in that caſe our year would be 475 times as long as it now is; but as we find the regular return of the ſeaſons, that is the completion of a whole year in 365 days and about 6 hours, it neceſſarily follows, that the earth muſt move round the ſun. Add to this, that, as the other planets, in their revolutions round the ſun, ſometimes move forward, ſometimes ſeem to ſtand ſtill, and ſometimes to move backward, all theſe irregularities are eaſily accounted for by ſuppoſing the earth to move round the ſun, but cannot be explained on the contrary ſuppoſition, of the ſun's moving round the earth.

Tyro. I beg leave, Sir, to mention one objection to the diurnal rotation of the earth on its own axis. If it moves, as you ſay, from weſt to eaſt, will not a ball, fired perpendicular upward in the air, fall conſiderably weſtward of the place from which it was ſhot?

Philo. By no means: for as both the gun and ball partake of the earth's motion, the ball will be carried forward with the air as quick as the earth and air turn, and will therefore fall on the very ſpot from which it was fired. Thus, if you let fall a ſtone from the top of a main-maſt, it will fall on the deck as near the foot of the maſt when the ſhip ſails as when ſhe is at reſt.

Tyro. Do the other planets, as well as the earth, turn round their axes?

Philo. Some of them do. Venus turns round her axis in 24 days, 8 hours; Mars in 24 hours, 40 minutes; and Jupiter in 9 hours, 56 minutes. Whether Mercury and Saturn have any revolution round their axes is not yet known. The ſun turns round his axes in 25 days, 6 hours; and the moon round hers in 29 days, 12 hours, and 44 minuets; that is, in the ſame time that ſhe revolves round the earth, ſo that ſhe has always the ſame face turned towards the earth.

Tyro. Is not the moon one of the planets?

Philo. She is; though not a primary, but only a ſecondary planet, or ſatellite; that is, an attendant upon the earth, about which ſhe revolves as her centre of motion, in the ſame manner as the earth revolves round the ſun from weſt to eaſt; and hence it is, that ſhe riſes every night conſiderably later than ſhe did the preceding one, except during harveſt, when, for ſeveral nights together, ſhe riſes, when at full, nearly at the ſame time; for which reaſon this moon is, by way of diſtinction, called the harveſt moon. When the moon is directly between the earth and the ſun, it cauſes an eclipſe of the ſun; and when the earth is directly between the ſun and the moon, it cauſes an eclipſe of the moon. The former always happens at new moon; the latter at full moon. But neither of them happen at every new and full moon: for, if they did, there would be twelve eclipſes of each luminary in the courſe of a year, whereas there are never more than ſeven, nor leſs than two.

Tyro. Have the other planets any moons?

Philo. Jupiter has four moons, and Saturn five. Mercury, Venus, and Mars, have no moons; at leaſt none that have yet been diſcovered. Saturn has, beſides, a thin, broad ring (which I mentioned above) that ſurrounds his body, without touching it, in the ſame manner as a horizon does an artificial globe. It is 21,000 miles in breadth, and is as far from Saturn on every ſide.

Tyro. Is the moon as big as the ſun, as ſhe appears to be?

Philo. So far from it, that ſhe is, at leaſt, 42,875,000 times leſs than the ſun. The reaſon of her appearing as big as the ſun is, that ſhe is much nearer the earth. Her diſtance from the earth is only 240,000 miles, whereas that of the ſun is 95 millions.

Tyro. What kind of bodies are the planets?

Philo. They are dark or opaque bodies, that have no light of their own, but ſhine by the re-reflected light of the ſun, which is a great body of fire, and is the ſource of light and heat to all other bodies in the ſolar ſyſtem.

Tyro. Are the planets inhabited?

Philo. They probably are; for it is not to be ſuppoſed that the Almighty created ſo many worlds for no other purpoſe, than merely to afford a faint glimmering light to the inhabitants of this earth, eſpecially as we might have enjoyed a much greater light at a far leſs expence, namely, by the addition of another moon.

Tyro. What do you mean by the comets?

Philo. The comets are certain dark or opaque bodies, like the planets, and move round the ſun, but in very eccentric orbits, being ſometimes ſo far from him, that their cold muſt be exceſſive, and ſomtimes ſo near him, that their heat muſt be ſo intenſe, as would prove altogether intolerable to an inhabitant of this earth; and would even deſtroy, or at leaſt vitrify, the earth itſelf. Sir Iſaac Newton computed the heat of the comet which appeared in 1680, when neareſt the ſun, to be 2000 times greater than that of red-hot iron; and that being thus heated, it muſt retain its heat until it comes round again, although its period ſhould be more than 20,000 years; and it is computed to be only 575. The theory of comets is not as yet very diſtinctly aſcertained. There are ſuppoſed to be 21 comets belonging to the ſolar ſyſtem; but the periods or returns of three of them only are known with any tolerable certainty. One of them was expected to return in 1789, but has not yet appeared. Comets are always attended with long tranſparent trains or tails, iſſuing from that ſide of them which is turned away from the ſun. Comets were formerly ſuppoſed to be prodigies or portents, and to foretel ſome great event or revolution, ſuch as the fall of empires, or the death of ſome eminent and diſtinguiſhed perſonage; but they are now known to have no more connection with the civil or political affairs of this world than any other of the heavenly bodies.

Tyro. What do you mean by the fixed ſtars?

Philo. All the other heavenly bodies, except the ſun, planets, and comets. They are called fixed ſtars, becauſe they always keep the ſame place, or relative diſtance from one another. Their number is probably infinite: but thoſe diſcoverable by the naked eye, do no exceed 1000; and thoſe diſcoverable by glaſſes, do not amount to above 2000; in all 3000. Their appearing ſo numerous, or rather numberleſs, to the naked eye, is owing to our looking upon them in a confuſed manner, and without reducing them to order. They are ſuppoſed to be ſuns, each of them as large as ours, and to have planets, both primary and ſecondary, revolving round them. What a grand and exalted idea does this give us of the works of creation, and of the power, wiſdom, and gooodneſs of the adorable Creator!

SUPPLEMENT.

SECT. I.

Concerning the true Figure and Magnitude of the EARTH, *with the Proportion of* LAND *and* WATER *on its Surface.*

THOUGH the earth be round, as we hope we have clearly demonſtrated in the beginning of this work (p. 2, 3, &c.) yet it is not an exact globe or ſphere, but only a ſpheroid; that is, a figure ſomewhat approaching to, or reſembling a ſphere, being flatted (like an orange) towards the poles, and ſwelling out towards the equator. This protuberance of the equatorial parts, and ſhrinking in of the polar regions, is owing to the centrifugal force ariſing from the earth's turning round its own axis in the ſpace of 24 hours: it is the ſame force, which a ſtone in a ſling is known to acquire by being ſwiftly whirled round in a circular manner, and by which it has a ſtrong tendency to recede or fly from the hand, or centre of motion. In like manner all the parts of the earth endeavour to fly off from the axis of motion, and would actually do ſo if they were not kept together by a far ſuperior force, viz. that of gravity, by which they conſtantly tend towards the earth's centre; this laſt, therefore, ſore, is called the centripetal force, and acts in direct oppoſition to the centrifugal.

When a ſtrong and a weak force act in oppoſition to each other, the effect of the former will be diminiſhed by the latter; and as the centrifugal force is greateſt in the parts about the equator, where the diſtance from the axis is greateſt of all, ſo the force of gravity will be there moſt diminiſhed by it, and conſequently all thoſe parts muſt have receded farther from the centre when the earth was firſt put in motion; and as all the parts of the earth are connected by a mutual coheſion, it follows, that in proportion as the equatorial parts receded, the Polar parts muſt have acceded or approached nearer to the centre, and therefore muſt have become flatter than the other parts; that is, the earth muſt have aſſumed the figure, not of a globe or ſphere, but, as we have already obſerved, of a ſpheroid. It appears from the principles of phyſics, that the force of gravity, or the centripetal force, is to the centrifugal as 289 to 1 under the equator; and the latter gradually decreaſes as you retire from the equator towards the poles, at which two laſt places it ceaſes to act entirerly; for there, as there is no rotatory motion of the earth, there is conſequently no centrifugal force, and in theſe two points therefore gravity exerts its full effect.

Now, ſince gravity gradually encreaſes from the equator to the poles, it will have a ſenſible influence upon the motion of long pendulums by encreaſing or diminiſhing their weight, in proportion as they are carried nearer to the poles or the equator; for, according as their weight is greater, they vibrate the quicker, and *vice verſa:* therefore a pendulum, which vibrates ſeconds at London, will not do the ſame at the equator, where gravity is leſs, and conſequently the pendulum lighter; for their it will vibrate ſlower, and the clock will by that means loſe time. The truth is, it was the irregular going of a pendulum clock which firſt ſuggeſted the idea of the different force of gravity in different latitudes; for in 1672, Mr. Richer carried a clock from Paris to Cayenne, in north lat. 4° 56' 17", where he found, that, in order to its beating ſeconds of mean time, it was neceſſary to ſhorten the pendulum one line and a quarter, or a little more than one tenth of an inch; which plainly proved, that gravity was leſs there than at Paris or London.

The ſpheroidical figure of the earth being once aſcertained, the next point to be determined was how much it differed from a real ſphere; and this, it was thought, might moſt effectually be done by meaſuring a degree of the meridian: fot it was well known, that, if the figure was not ſpherical, the degrees could not be equal in different latitudes, but muſt be leſs near the equator, where the earth was rounder, and greater towards the poles, where it was flatter.

This taſk, therefore, of meaſuring a degree of the meridian, was firſt undertaken by the famous Caſſini, who in 1718 meaſured the length of the meridian through France, and found that a degree in the parallel of 49° 22' was equal to 57,183 toiſes. In 1735, by the joint order of the Kings of France and Spain, a degree was meaſured at Quito, in Peru, in latitude 1° 10', and was found there equal to 56,767$\frac{4}{5}$ toiſes. In 1736, by the French King's order, a degree was meaſured at the Arctic circle, and found to contain 57,438 toiſes. 824 toiſes are equal to an Engliſh mile.

From theſe ſeveral meaſures of a degree in the different parts of the meridian, it is found by calculation, that the axis of the Earth is to a diameter of the equator as 1019 to 1024. And it is from thence alſo found, that the axis of the earth is 7932 miles, and a diameter of the equator 7971, which therefore exceeds the axis by 39 miles. By the ſame calculation it is likewiſe found, that a degree at the pole exceeds a degree at the equator by 830 toiſes, or a little more than an Engliſh mile; and that a degree of the meridian in the parallel of 54° 44' is equal to a degree on the equator, which exceeds the firſt degree of the meridian by 546 toiſes. If we add the toiſes in the two extreme degrees of the meridian together, half the ſum will be 57,041, which is the length of a mean degree, or degree in the meridian of a globe juſt equal in bulk to our ſpheroidical earth. Then divide 57,041 by 824, and the quotient $69\frac{185}{824}$ will be the length of a degree in a great circle of ſuch a globe; which multiplied by 360, will give 24,922 miles for the circumference of a globe equal to the earth; whoſe diameter therefore will be 7933 Engliſh miles. The diameter of the earth being known, the ſquare miles contained in its ſurface will be 197,706,226; and its ſolid contents in cubic miles will be upwards of 26,139,500,000, or near 26,140 millions.

As to the proportion, which the land bears to the water on the ſurface of the earth, it is perhaps impoſſible to determine it exactly. Some probable conjecture, however, may be formed with regard to it by the following experiment: Suppoſe, of the papers that cover the artificial globe, you cut out carefully, with a pair of ſciſſars, thoſe parts that repreſent land, and wheigh them in a nice balance. Then do the ſame with thoſe parts that repreſent water; and the weight of the two parcels of papers compared together will give you the proportion of the land to the water.

This I have ſeen done with the papers that cover the ſurface of Mr. Senex's 28 inch globe, and the reſult was as follows: The papers repreſenting land weighed 367 grains, and thoſe repreſenting water 1125 grains. The weight therefore of the whole was 1492 grains, a fourth part of which is 373 grains, which is more than the weight of the land 367, though very near it. The proportion therefore of land to water is as 1 to 3, or the land is ¼ of the earth's ſurface very nearly.

SECT.

SECT. II.

Of the ATMOSPHERE.

THE air is that thin, inviſible fluid, which ſurrounds the earth to a conſiderable height; accompanies it in its diernal motion round its own axis, and in its annual motion round the ſun: in ſhort, it is that in which we live and breathe, and, together with the clouds and vapours, that float in it, is called the atmoſphere. The air is juſtly reckoned among the number of fluids, becauſe it has all the properties by which a fluid is diſtinguiſhed. It yields to the ſmalleſt force impreſſed on it; its parts are eaſily moved among themſelves; it preſſes according to its perpendicular height; and its preſſure is every way equal.

That the air is a fluid, conſiſting of ſuch particles as have no coheſion betwixt them, but eaſily glide over one another, and yield to the ſlighteſt impreſſion, appears from that eaſe and freedom with which animals breathe in it, and move through it without any difficulty or ſenſible reſiſtance. But it differs from all other fluids in the four following particulars: 1. It can be compreſſed into a much leſs ſpace than that which it naturally occupies which no other fluid can, at leaſt not to any conſiderable degree.* 2. It cannot be congealed or fixed, as other fluids may. 3. It is of a different denſity in every part upward from the earth's ſurface, decreaſing in its weight, bulk for bulk, the higher it riſes; and therefore muſt alſo decreaſe in denſity. 4. It is of an elaſtic of ſpringy nature, and the force of its ſpring is equal to its weight.

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* It has been found by late experiments, that water may be compreſſed, though not very much.

That air is a body, is evident from its excluding all other bodies out of the ſpace it poſſeſſes; for if a glaſs jar be plunged with its mouth downward into a veſſel of water, there will but very little water get into the jar, becauſe the air, of which it is full, keeps the water out. As air is a body, it muſt needs have gravity or weight; and that it is weighty may be thus proved. Let the air be taken out of a veſſel by means of the air pump; then, having weighed the veſſel, let the air in again; and upon weighing it when re-filled with air, it will be found conſiderably heavier. Thus a bottle, that holds a wine quart, being emptied of air and weighed, is found to be about 16 grains lighter than when the air is let into it again; wdich ſhews, that a quart of air weighs 16 grains. But a quart of water weighs 14,621 grains; this divided by 16, quotes 914 in round numbers; which ſhews that water is 914 times as heavy as air near the ſurface of the earth.

As the air riſes above the earth's ſurface, it grows thinner or rarer, and conſequently lighter, bulk for bulk. For as it is of an elaſtic or ſpringy nature, the upper parts, being leſs preſſed than the lower, will for that reaſon expand themſelves, and occupy a larger ſpace.

Dr. Cotes has proved, that if altitudes in the air be taken in arithmetical proportion, the rarity of the air will be in geometrical proportion. Thus, at the height of 7 miles, the air is 4 times thinner and lighter than at the ſurface of the earth; at the height of 14 miles, it is ſixteen times thinner and lighter; at 21 miles, it is 64 times; at 28 miles, it is 256 times; at 35 miles, it is 1024; and ſo on continually, the latter numbers encreaſing in geometrical, as the former do in arithmetical proportion. And hence it is eaſy to prove, that a cubic inch of ſuch air as we breathe, would be ſo much rarefied at the altitude of 500 miles, that it would fill a hollow ſphere equal in diameter to the orbit of Saturn.

But the real weight or preſſure of the air is moſt exactly determined by what is commonly called the Torricellian experiment, which is performed in this manner: Take a glaſs tube about three feet long, and open at one end; fill it with quickſilver, and putting your finger upon the open end, turn that end downward, and immerſe it into a ſmall veſſel of quickſilver, without letting in any air: then take away your finger; and the quickſilver will remain ſuſpended in the tube 29½ inches above the ſurface in the veſſel; ſometimes more, and at other times leſs, as the weight of the air is varied by winds and other cauſes.

That the quickſilver in the tube is kept up by the preſſure of the atmoſphere upon that in the baſon, is evident from this, that if the baſon and tube be put under a glaſs, and the air be then taken out of the glaſs, all the quickſilver in the tube will fall down into the baſon; and if the air be let in again, the quickſilver will riſe to the ſame height as before. Therefore the air's preſſure on the ſurface of the earth is equal to the weight of 29½ inches of quickſilver all over the earth's ſurface at a mean rate. A ſquare column of quickſilver, 29½ inches high, and one inch thick, weighs juſt 15 pounds, which is equal to the preſſure of air upon every ſquare inch of the earth's ſurface; and 144 times as much, or 2160 pounds, upon every ſquare foot; becauſe a ſquare foot contains 144 ſquare inches. At this rate, a middle-ſized man, whoſe ſurface may be about 14 ſquare feet, ſuſtains a preſſure of 30,240 pounds, when the air is of a mean gravity; a preſſure, which would be inſupportable, and even fatal to us, were it not equal on every part, and counterbalanced by the ſpring of the air within us, which is diffuſed through the whole body, and re-acts with an equal force againſt the outward preſſure.

Now, ſince the earth's ſurface contains (in round numbers) 200,000,000 ſquare miles, and every ſquare mile 27,878,400 ſquare feet, there muſt be 5,575,680,000,000,000 ſquare feet on the earth's ſurface; which multiplied by 2160 pounds (the preſſure on each ſquare foot) gives 12,043,468,800,000,000,000 pounds for the preſſure or weight of the whole atmoſphere.

The ſame cauſe, that makes mercury aſcend in a tube to the height of 29½ inches, is the occaſion of water aſcending in a pump to the height of 33 feet; for it will aſcend no higher: ſo that a column of water 33 feet high, is equal in weight to a column of quickſilver of the ſame diameter, 29½ inches high; and to as thick a column of air, reaching from the earth's ſurface to the top of the atmoſphere.

The inſtrument, with which the Torricellian experiment is performed, being now generally uſed to determine the changes in the weight of the air, and conſequently the changes of the weather, is for that reaſon called the barometer, or weather-glaſs. Sometimes the air is ſo heavy and elaſtic, as to ſupport the mercury in the tube at the height of 31 inches; at other times it is ſo light and unelaſtic, as to ſuffer it to fall below 28 inches. The difference between theſe is three inches, that is, about 1-9th of the whole weight of the atmoſphere. Our bodies, therefore, are ſometimes preſſed with a weight one ninth more, or one ninth leſs than they are at other times, that is, with about 3360 pounds more weight at one time than another. This muſt no doubt have a conſiderable effect on our feelings, and conſequently upon our health; and the fact is, that it has ſo: but we are apt to aſcribe this effect to a wrong cauſe. When we feel ourſelves dull and languid, we think it is owing to the air's being two thick and heavy about us. But it is juſt the reverſe. The air is then too light and thin, as is evident from its wanting ſtrength to bear up the vapours that compoſe the clouds, and from the mercury's ſinking in the barometer. On the contrary, when the air is thick and heavy, the clouds mount high, the air becomes more ſtrong and elaſtic, by which means it balances the ſpring of air within us, braces up our blood-veſſels and nerves, and makes us briſk and lively.

It is impoſſible, in a ſhort ſketch of this kind, to explain all the uſes and properties of the air: I ſhall therefore content myſelf with mentioning a few more of the moſt remarkable. According to Dr. Keill, and other aſtronomical writers, it is entirely owing to the atmoſphere that the heavens appear bright in the day-time. For, without the atmoſphere, only that part of the heavens would ſhine in which the ſun was placed; and if we could live without air, and ſhould turn our backs towards the ſun, the whole heavens would appear as dark as in the night, and the ſtars would be ſeen as clear as in the nocturnal ſky. In this caſe we ſhould have no twilight; but a ſudden tranſition from the brighteſt ſunſhine to the blackeſt darkneſs immediately after ſun-ſet; and from the blackeſt darkneſs to the brighteſt ſunſhine at ſun-riſing; which would be extremely inconvenient, if not blinding, to all mortals. But, by means of the atmoſphere, we enjoy the ſun's light, reflected from the ærial particles, for ſome time before he riſes, and after he ſets. For, when the ſun has deſcended below the horizon, and conſequently is concealed from our ſight, the atmoſphere, being higher than we, has his light ſtill imparted to it, and reflects it to us. This light, or rather twilight, gradually decreaſes, till the ſun has got 18 degrees below the horizon; and then all that part of the atmoſphere which is above us is dark. From the length of the twilight the Doctor has calculated the height of the atmoſphere (ſo far as it is denſe enough to reflect any light) to be about 44 miles. But it is ſeldom denſe enough at two miles height to bear up the clouds. The real height, however, of the atmoſphere cannot well be aſcertained: It grows gradually rarer and rarer, the higher it aſcends; and as it is impoſſible to ſet any bounds to its rarefaction, it ſeems equally impoſſible to fix any limits to its height.

The air is rarefied, or made to ſwell with heat; and of this property wind is the neceſſary conſequence. For when any part of the air is heated by the ſun, or otherwiſe, it will ſwell, and thereby affect the adjacent air; and ſo, by various degrees of heat in different places, there will ariſe various winds. When the air is much heated, it will aſcend towards the upper part of the atmoſphere, and the adjacent air will ruſh in to ſupply its place; and therefore there will be a ſtream or current of air from all parts towards the place where the heat is. And hence we ſet the reaſon why the air ruſhes with ſuch force into a glaſs-houſe, or tile-kiln, or towards any place where a great fire is made; and alſo why ſmoke is carried up a chimney, and why the air ruſhes in at the key-hole of the door, or any ſmall chink, when there is a fire in the room. So, in general, we may conclude, that the air will preſs towards that part of the world where it is moſt heated. Upon this principle we can eaſily account for the trade winds, which conſtantly blow from eaſt to weſt between the tropics, and chiefly about the equator. For as the ſun moves from eaſt to weſt, and as the air immediately under the ſun muſt be more ſtrongly heated than that upon any other part of the earth's ſurface, it will naturally aſcend into the higher regions, and the adjacent air will as naturally ruſh in to ſupply its place; and thus a conſtant ſtream or current of air, that is of wind, will follow the ſun in his daily courſe from eaſt to weſt; only, on the north-ſide of the equator, it will incline a little to the north, and on the ſouth ſide, to the ſouth.

This general courſe of the wind about the equator is changed in ſeveral places, and by a variety of cauſes. 1. By exhalations. 2. By the falling of great quantities of rain, which condenſe the air. 3. By burning ſands, which rarefy it. 4. By chains of high mountains, which break its current, and alter its direction. And 5. By the declination of the ſun towards the north ſide of the equator in ſummer, and towards the ſouth ſide of it in winter. To theſe, and other cauſes of a ſimilar nature, are owing, 1. The irregularity and uncertainty of the winds in climates at a conſiderable diſtance from the equator, as in moſt parts of Europe. 2. Thoſe periodical winds, called monſoons, which in the Indian ſeas blow half a year one way, and the other half another. 3. Thoſe winds, which, on the coaſt of Guinea, in Africa, and on that part of Peru in South America, blow almoſt always from the weſt. 4. The ſea and land breezes, which, in hot countries, blow generally from the ſea in the day time, and from the land in the night, but which do not extend above two or three leagues from the ſhore. And, 5. All thoſe ſtorms, hurricanes, whirlwinds, and irregularities which happen at different times and places.

All common air is impregnated with a certain vivifying ſpirit or quality, which is neceſſary to continue the lives of annimals; and this, in a gallon of air, is ſufficient for one man during the ſpace of a minute, and not much longer. This ſpirit in air is diſtroyed by paſſing through the lungs of animals; and hence it is that an animal dies ſoon, after being put under a veſſel which admits no freſh air to come to it.

This ſpirit is alſo in the air which is in water, but requires a conſtant ſupply from the atmoſphere above; for fiſh die when they are excluded from freſh air, as in a pond that is cloſely frozen over. And the little eggs of inſects, if ſtopped up in a glaſs, will not produce their young, though aſſiſted by a kindly warmth; neither will the ſeeds of plants grow, though mixed with good earth, if they are incloſed in a glaſs. This enlivening quality in air is alſo deſtroyed by the air's paſſing through fire, particularly charcoal fire, or the flame of ſulphur; and hence it is, that ſmoky chimnies muſt be very unwholſome, eſpecially if the rooms they are in be ſmall and cloſe. Air is alſo corrupted by remaining cloſely pent up in any place for a conſiderable time; as in the holds of ſhips, in oil-ciſterns or wine cellars, and in deep pits or wells that have been long diſuſed and covered over. In all theſe the air is ſometimes ſo much vitiated, as to prove inſtant death to any animal that comes into it. The corruption of this vivifying ſpirit in air ſeems to be the real cauſe of epidemical diſeaſes, and ſtill more of peſtilential and contagious diſorders.

It is well known, that the atmoſphere is the common receptacle of all the exhalations and vapours that ariſe from different bodies; of the ſteam and ſmoke of things burnt or melted; the fogs or vapours proceeding from damp watery places; and of the effluvia from ſulphureous, nitrous, acid, and alkaline bodies. In a word, whatever may be called volatile, riſes in the air to greater or leſs heights according to its ſpecific gravity. When the effluvia, which ariſe from acid and alkaline bodies, meet each other in the air, there will be a ſtrong conflict or fermentation between them; which will ſometimes be ſo great as to pruduce a fire; and if the effluvia be combuſtible, the fire will run from one part to another, juſt as the inflammable matter happens to lie.

That this will be the couſequence of two ſuch ſubſtances coming in contact may be eaſily proved by mixing an acid and an alkaline fluid together, as the ſpirit of nitre and the oil of cloves; upon the doing of which a ſudden ferment, with a fine flame, will ariſe; and if the ingredients be very pure and ſtrong, there will be a ſudden exploſion.

Whoever conſiders the nature of fermentation, will be at no loſs to account for the dreadful effects of thunder and lightning; for the effluvia of ſulphureous and nitrous bodies, and others that riſe into the atmoſphere, will ferment with each other, and take fire, ſometimes by the aſſiſtance of the ſun's heat, and very often of themſelves. If the inflammable matter be thin and light, it will mount up into the higher regions of the air, where it will flaſh without making any noiſe, or doing any harm; but if it be thick and heavy, it will lie near the ſurface of the earth, where taking fire, it will explode with a ſurpriſing force; and by its heat rarefy and drive away the air, kill men and cattle, ſplit trees, walls, rocks, &c. and be accompanied with a terrible noiſe, or loud claps of thunder. The heat of lightning appears to be of a quite different nature from that of other fires; for it has been known to melt a ſword without hurting the ſcabbard in which it was ſheathed; and money in a man's pocket, without hurting the pocket itſelf;

ſelf; the reaſon of which ſeems to be, that, by its great ſubtilty, it eaſily paſſes through looſe or ſoft bodies, and ſpends its force chiefly upon the hard ones.

Much of the ſame kind with lightning are thoſe exploſions, called fulminating, or fire-damps, which ſometimes happen in mines; and are occaſioned by ſulphureous and nitrous, or rather oleaginous particles, riſing from the mine, and mixing with the air, where they will be ſet on fire by the lights which the workmen are obliged to make uſe of. Such air may be artificially produced in the following manner. Exauſt the receiver of an air-pump, and let the air into it through the flame of the oil of turpentine; then if you remove the cover of the receiver, and hold a candle to that air, it will take fire, and burn more or leſs intenſely, according to the denſity of the oleaginous matter.

When ſuch combuſtible matter, as we have now mentioned, kindles in the bowels of the earth, where there is little or no vent, it produces earthquakes, and violent ſtorms and hurricanes of wind, when it breaks forth into the air. An artificial earthquake may be made thus: Take 20 or even 10 pounds of iron filings, and as many of ſulphur; mix, work and temper the whole with a little water, ſo as to form a maſs of the conſiſtence of a firm paſte. This, being buried three or four feet under ground, will, in 6 or 7 hours time, have a prodigious effect: the earth will begin to tremble,

ble, crack and ſmoke, and fire and flame will burſt out. From this experiment we may form a very probable conjecture as to the cauſe of the eruptions of Mount Ætna, Veſuvius, and other volcanos, theſe being, in all likelihood, ſet on fire at firſt by the mixture of metalline and ſulphureous particles.

N. B. Thunder and lightning, and even earthquakes, have of late been attempted to be ſolved upon very different principles, viz. thoſe of electricity. It is probable, indeed, that the electric matter, which pervades all nature, and particularly the atmoſphere and the body of the earth, has a conſiderable ſhare in producing, though it be not the ſole cauſe of, theſe terrible phænomena.

SECT. III.

Of the TIDES.

A Tide is that motion of the water in the ſeas and rivers, by which it is found regularly to riſe and fall. The general cauſe of this motion of the water ſeems to have been firſt diſcovered by Kepler, who, in his *Introduction to the Phyſics of the Heavens*, expreſſes himſelf thus: "The orb of the attracting power of the moon extends as far as the earth, and draws the waters under the torrid zone, acting upon thoſe places where it is vertical; inſenſibly, indeed, on confined ſeas and bays, but ſenſibly on the ocean, whoſe beds are large, and whoſe waters have the liberty of reciprocation, that is, of riſing and falling." And, in his *Lunar Aſtronomy*, he ſays, "That the cauſe of the tides of the ſea appears to be the bodies of the ſun and moon drawing the waters of the ſea." This hint being given, the immortal Sir Iſaac Newton improved it, and wrote ſo fully and ſatisfactorily on the ſubject, as to make it in a great meaſure his own, particularly by explaining the reaſon why the waters riſe on that ſide of the earth which is fartheſt from the moon, as well as on that which is neareſt to her. The ſubſtance of what he ſays on this curious topic is as follows.

The two great powers, that actuate all matter, are gravity and attraction. By the former, all bodies tend towards the centre of the earth; and the caſe is no doubt the ſame in all other ſpheres or globes. By the latter, the ſun, the moon and the earth, and probably too the other planets, mutually draw or attract each other; but with forces, however, which gradually decreaſe as the diſtances of the attracting bodies decreaſe, and that too in proportion to the ſquare of thoſe diſtances; in other words, at double the diſtance the power of attraction is four times leſs, at triple the diſtance it is nine times leſs, at quadruple the diſtance it is ſixteen times leſs, at five times the diſtance it is twenty-five times leſs, &c.

Now, as the earth is attracted by the ſun and moon, therefore all the parts of the earth will not gravitate towards its centre in the ſame manner as if thoſe parts were not affected by ſuch attractions. And it is evident, that, were the earth entirely free from ſuch actions of the ſun and moon, the ocean tending equally, on all ſides, towards its centre by the force of gravity, would maintain a perfectly ſpherical figure. But as the caſe is otherwiſe, the water of the ocean muſt needs riſe higher in thoſe places where the ſun and moon diminiſh its gravity, or where the ſun and moon have the greateſt attraction.

The moon, however, being by much the neareſt of theſe two luminaries, will operate with the greateſt force in producing this riſe of the waters, or the ebbing and flowing of the ſea; and its influence in this reſpect muſt be as follows: Firſt upon the hemiſphere towards the moon; where the middle point being neareſt the moon, and therefore moſt attracted by her (directly contrary to its natural gravity, or tendency to the centre) is leſs preſſed by gravitation than any other part of the ſurface of that hemiſphere, and conſequently the waters will there be the higheſt. Secondly, upon the hemiſphere that is fartheſt from the moon; where the middle point being leaſt attracted by the moon (by reaſon of its being at the greateſt diſtance from her) is left behind, while all the other parts, and even the centre itſelf, are more attracted towards her; from whence it will follow, that the ſurface of the water at the middle of that hemiſphere will be higher, or more remote from the centre, than any other part of it.

On the other hand, thoſe parts of the earth, where the moon appears in the horizon, or is 90 degrees diſtant from the Zenith and Nadir, will have the ebbs or loweſt waters. For, as the waters in the Zenith and Nadir riſe at the ſame time, the waters in the neighbourhood will ruſh in towards them, in order to maintain the equilibrium; and to ſupply the place of theſe laſt, others will move the ſame way, and ſo on gradually, till the motion reaches to 90 degrees diſtance, from the ſaid Zenith and Nadir; conſequently in thoſe place where the moon appears in the horizon, or which are 90 degrees diſtant from the Zenith and Nadir, the waters will be the loweſt.

That part of the globe, therefore, which is neareſt to the moon, and that which is fartheſt from her, will naturally be the higheſt in their reſpective hemiſpheres; the former being really more elevated, and the latter leſs depreſſed, by the moon's attraction, than the adjacent parts: ſo that theſe two points may now be conceived as the ſummits of two oppoſite mountains of water, or the whole globe may be ſuppoſed to be thrown into a ſpheroidical or oval figure, whoſe longeſt diameter, if produced, would paſs through the moon, and its ſhorteſt be where ſhe is in the horizon, or at 90 degrees diſtance. And as the moon ſeems to move round the earth from eaſt to weſt, the longer diameter of the ſpheroid, following her motion, will occaſion the two tides of flood and the two tides of ebb that happen in about 25 hours; for that is the time nearly, which the moon takes up in moving from the meridian of any place to the ſame meridian again.*

When the ſun and moon are in conjunction, or oppoſition, that is, at new or full moon, the attraction of both theſe bodies acting upon the earth in the ſame direction, or in the ſame right line, their force is united to elevate the waters; and conſequently then there will be ſpring-tides. When the moon is in her quadratures, her attraction acts in one direction, and the ſun's in a quite contrary; by which means they oppoſe or counteract one another, the moon raiſing the waters where the ſun depreſſes them, and *vice verſa*; the conſequence of which is, that then there will be neap-tides.

Though the force by which the tides are raiſed, is continually encreaſing from the time of the moon's quadrature to her conjunction or oppoſition, after which it gradually decreaſes till the next quadrature; yet the higheſt ſpring-tide is not juſt at the new or full moon, but a day or two after; which may be eaſily accounted for thus: conceive every tide as raiſed by a double force, viz. ſome part of the force that raiſed the laſt tide ſtill remaining, and the force of a new impulſe. When both theſe together amount to more than the whole force which raiſed the laſt tide, the preſent tide muſt riſe higher than the preceding one did. Suppoſe the remaining force to be always half the whole force of the laſt tide; ſuppoſe the new impulſe, juſt at new or full moon, to be 18, and the whole force, with which that tide is raiſed, to be 28. Let the new impulſe of the new tide be but 17; then 17 + 14 (that is, half of 28) = 31: this tide will therefore riſe higher than the laſt. Let the new impulſe of the next tide be but 16; then 16 + 15½ (that is, half of 31) = 31½: conſequently this tide will riſe ſtill higher than the laſt did, though the force of the attraction of the two luminaries, by which the tides are raiſed, is now conſiderably diminiſhed. For the ſame reaſon the deadeſt neap-tides will fall out, not preciſely at the moon's quarters, but ſome time after.

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* *Note.* The reaſon why the moon takes up about 25 hours in moving from any one meridian to the ſame meridian again, is, that though in her daily courſe ſhe ſeems to move round the earth from eaſt to weſt, yet ſhe really moves round it from weſt to eaſt in the ſpace of a month.

If the two oppoſite protuberances or ſummits of the two mountains of water, we have mentioned above, were always exactly at the poles of the earth, there would be no riſing and falling of the waters by means of the earth's rotation round its axis, or no tides at all, becauſe at the poles the earth has no rotatory motion round its axis; and in this caſe it would conſtantly be high water at the poles, and low water at the Equator. On the other hand, when theſe two ſummits are fartheſt from the poles, that is, upon the Equator, the riſe and fall of the waters, by means of the earth's rotation, will be the greateſt; for the two ſummits then deſcribing a great circle of the globe in the ſame time they uſed to deſcribe a leſſer circle parallel to the Equator, will conſequently move with greater rapidity, and being daſhed againſt the ſhores with greater force, will for that reaſon riſe the higher.

In general, therefore, it may be laid down as a maxim that the nearer any place is to the Equator, the riſe and fall of the waters will be the greater; and the nearer it is to the poles, the riſe and fall will be the leſs. And as the riſe of the water is owing to the joint influence of the ſun and moon, it naturally follows, that when theſe two luminaries are in conjunction or oppoſition, in or near the equinoctial, as in March and September, the ſpring-tides muſt riſe higher, (the ſummits of the two mountains being then upon the Equator) than when they are in conjunction or oppoſition in the tropics, as in June and December; and, for the very ſame reaſon, the neap-tides are weaker in the two former months than they are in the latter. Yet, though the higheſt tides happen at the equinoxes, they do not fall exactly on the equinoctial days, but ſome time before the vernal, and ſome time after the autumnal equinox, viz. in February and October; the reaſon of which is, that the ſun being nearer the earth in the winter months than he is in the ſummer ones, his attractive power muſt conſequently be ſtronger in the former than it is in the latter.

It is equally certain from what has been ſaid, that the greater the moon's meridian altitude is in any place, the greater will be thoſe tides which happen when ſhe is above the horizon; and the greater her meridian depreſſion is, the greater will be thoſe tides which happen when ſhe is below the horizon. Moreover, the ſummer day, and the winter night tides have a tendency to be the higheſt, becauſe the ſun's ſummer altitude, and his winter depreſſion, are the greateſt; but this is more particularly the caſe when the moon has north declination in ſummer, and ſouth declination in winter.

All the phœnomena, hitherto explained, would exactly take place, were the whole ſurface of the earth covered with water. But as it is not, and as the natural courſe of the tides from eaſt to weſt is interrupted by large continents, and by an infinite number of iſlands, there conſequently muſt ariſe, in many places near the land, a great variety of other appearances beſide thoſe I have mentioned. Theſe appearances, therefore, will require a particular ſolution; and in this we muſt attend to the ſituation of ſhores, ſtraits, ſhoals, winds, and many other things which help to produce them.

For inſtance; as the ſea has no viſible paſſage between Europe and Africa, let them be ſuppoſed to be one continent, extending from 72 degrees north to 34 degrees ſouth latitude: the middle between theſe two would be in latitude 19 degrees north, near Cape Blanco on the weſt coaſt of Africa. But it is impoſſible that the tide ſhould flow to the weſtward upon the weſtern coaſt of Africa, becauſe the continent for above 50 degrees, both northward and ſouthward, bounds the Atlantic ocean on the eaſt, and prevents the direct paſſage of the tide, either from the Indian or the Pacific ocean into it: therefore, if any regular tide, occaſioned by the motion of the ſea, from eaſt to weſt, ſhould reach Cape Blanco, it muſt come either from the north of Europe ſouthward, or from the ſouth of Africa northward, to the ſaid latitude upon the weſt coaſt of Africa. And this theory is perfectly agreeable to fact and experience; for it is well known, that the tide flows ſouthward along the weſt coaſt of Norway, from the north cape to the Naze, or entrance of the Baltic ſea, and ſo proceeds to the ſouthward along the eaſt coaſt of Great Britain, and in its paſſage ſupplies all the harbours in thoſe parts, with the tide one after another, the coaſt of Scotland having the tide firſt, as lying fartheſt to the northward. Thus, on the days of the full, or change, it is high water at Aberdeen 45 minutes after 12; but at Tinmouth Bar, the ſame day, not till three o'clock. From thence, rolling to the ſouthward, it makes high water at the Spurn a little after 5; but not till 6 at Hull, by reaſon of the time required for its paſſage up the river; from thence paſſing over the Wellbank into Yarmouth-road, it makes high water there a little after 8, but not in the pier till 9; and it requires near an hour more to make high water at Yarmouth town: in the mean time continuing its courſe to the ſouthward, it makes high water at Harwich at half paſt 10, at the Nore at 12, at Graveſend at half paſt 1, and at London at 3 o'clock. Thus it appears, that the ſame tide, which produces high water at Tinmouth Bar at 3 o'clock in the morning, does not produce high water at London till three in the afternoon.

While the tide, or high water, is thus gliding to the ſouthward along the eaſt coaſt of England, it alſo flows to the ſouthward along the weſt coaſts of Scotland and Ireland, and a branch of it falls into St. George's Channel, the flood running up north-eaſt, as may be naturally inferred from its being high water at Waterford above three hours before it is high water at Dublin, or thereabouts, on that coaſt; and it is three quarters of an hour ebb at Dublin before it is high water at the Iſle of Man.

But, not to draw out this article to too great a length, I ſhall content myſelf with obſerving, that the tide flows to the ſouthward from the coaſt of Ireland, and in its paſſage a branch of it falls into the Engliſh Channel between the Lizard and Uſhant; this progreſs of the tide to the ſouthward may eaſily be proved by its being high water on the day of the full and changes at Cape Clear a little after 4 o'clock, and at Uſhant about 6, and at the Lizard after 7. The Lizard and Uſhant may properly be called the chaps of the Engliſh Channel, between which the tide flows to the eaſtward along the coaſts of England and France, till it comes to the Goodwin or Galloper, where it meets the tide above mentioned, which flows to the ſouthward along the eaſtern coaſt of England; and the meeting of theſe two tides contributes very much towards ſending a powerful tide up the river Thames to London. And when the natural courſe of theſe two tides has been interrupted by a ſudden change of the wind, by which means that tide was accelerated which had before been retarded, and that driven back which was before hurried in by the wind, it has been known to occaſion high water twice in 3 or 4 hours, which by thoſe who did not underſtand this natural cauſe, has been looked upon as a prodigy.

If it ſhould be ſaid, that this courſe of the tides eaſt, or eaſt-north eaſt, up the channel, is inconſiſtent with the theory which ſuppoſes them to move from eaſt to weſt, the anſwer is obvious. Though in the main ocean, where the tides meet with no obſtruction, they regularly follow the influence of the ſun and moon in moving from eaſt to weſt, yet in rivers, channels, and even in narrow ſeas, they ſometimes move towards the north, the ſouth, or even towards the eaſt, according as the waters in the neighbourhood are higher or lower.

This will be eaſily underſtood by any one, who is ſufficiently acquainted with hydroſtaticks to know, that water, if not counteracted by ſome ſuperior power, always endeavours to come to a level.

There are no tides in lakes, becauſe they are generally ſo ſmall, that when the moon is vertical ſhe attracts every part of them alike, and as all the water is thus rendered equally light, no part of it can riſe higher than another. To the ſame cauſe it is ſuppoſed to be owing, that the Mediterranean and Baltic ſeas have no tides, at leaſt no very perceptible ones; though a different reaſon is ſometimes aſſigned for this phœnomenon, and that is, that the inlets, by which theſe ſeas communicate with the ocean, are ſo ſmall, as not to be capable, in the ſpace of a few hours, to receive or diſcharge a ſufficient quantity of water to raiſe or ſink their ſurfaces conſiderably. The time of high water, in any place, happens about the ſame hour after a period of 15 days nearly, which is the interval between one ſpring tide and another; and during that period the time of high water happens every day later by about 48 minutes.

We ſhall conclude this account of the tides with a few words concerning the ſaltneſs and depth of the ſea. Dr. Halley has aſſigned the moſt probable cauſe of its ſaltneſs. He ſays, that all the lakes in the world, properly ſo called, are found to be ſalt; ſome more, ſome leſs than the ocean, which in the preſent caſe may alſo be conſidered as a lake; ſince by that term is meant nothing more than ſuch ſtanding waters as perpetually receive rivers running into them, and have no exit or evacuation, but what is exhaled by heat. And having given us a liſt of the moſt remarkable lakes, he ſuppoſes, that as all thoſe lakes receive rivers, and none of them have any diſcharge but by exhalation, ſo it will be neceſſary, that their waters riſe till ſuch time as their ſurfaces are ſufficiently extended to make them exhale in vapour as much water as is poured in by the rivers. But the vapours thus exhaled are perfectly freſh; ſo that the ſaline particles, that are brought in by the rivers, remain behind, while the freſh ones only evaporate; and hence it is evident, that the ſalt in the lakes will be continually augmented, and the water grow ſalter and ſalter. But in lakes where the water runs off as faſt as the freſh water rivers pour in, the ſaline particles can never be accumulated to any conſiderable degree. Now if this be the true cauſe of the ſaltneſs of lakes, it is not improbable that it may likewiſe be the reaſon of the ſaltneſs of the ſea.

That exhalations from ſea water are perfectly freſh, is proved by a variety of experiments; conſequently all rain, hail, and ſnow is freſh, and ſo muſt the rivers be that originate from or are ſupplied by them. Rain water, juſt fallen, is ſuppoſed to be the pureſt and lighteſt of all waters with regard to earthy particles; and as it is reckoned to be of the ſame kind wherever it falls, philoſophers have choſen it to be the meaſure, with which the weight of all other bodies is beſt compared. After all, there is no water perfectly pure; for even this rain water abounds with the eggs of many very ſmall animals, which, floating in the atmoſphere, are brought by the rain to the earth. The water of ſprings and rivers is generally impregnated with the particles of earths, ſalts, ſulphurs, minerals, &c. which the water is ſtrained through, or runs over; and is, for that reaſon, ſomewhat heavier than rain water, though not ſo heavy as ſea water, on account of the quantity of ſalt with which the latter is impregnated.

The depth of water in the ſea is various. In many places its bottom may be found by a piece of lead tied to the end of a long line, and even the nature of its bottom aſcertained by filling the lower end of the lead with tallow, by which means it will bring up, ſticking to it, ſome of the looſe particles from the bottom of the ſea, and thereby ſhew the nature of that bottom, whether it be ſand, gravel, ſhells, mud, &c. And though in many places no bottom can be found by ſounding, or letting down the lead, it muſt not thence be inferred that the ſea has no bottom. It has been conjectured, with great probability, that the depths of the ſea, and the heights of the land above the ſurface of the ſea, are not very different. Now it is well known, that there is no land, or ſummit of a mountain, more than three or four miles in perpendicular height above the level of the ſea; therefore it may be ſuppoſed, that the ſea is not much more than three or four miles deep in any part; and could an exact repreſentation be given of the depths of the ſea in different places, it would probably appear, that it has much the ſame irregularity in its bottom, as the land has in its ſurface.

SECT. IV.

A SHORT SYSTEM *of* CHRONOLOGY.

CHRONOLOGY, or the doctrine of time, is intimately connected with the uſe of the globes, inaſmuch as many of the problems require a perſon to be thoroughly acquainted with the nature of years, months, and days; and alſo as both the Julian and Gregorian calendars, or (as they are commonly called) the Old and New Stile, are inſcribed upon the Horizons of many globes, and therefore ought to be explained in all books that treat of their uſe.

Time is divided into days, hours, weeks, months, and years. Days are either natural or artificial. A natural day is the time that paſſes while the ſun goes from any meridian till he returns to it again; or, to ſpeak more properly, while the earth revolves round its axis. An artificial day is the time between the ſun's riſing and ſetting; to which is oppoſed the night, that is, the time the ſun is hid under the Horizon. The natural day is divided into 24 hours, each hour into 60 minutes, each minute into 60 ſeconds, each ſecond into 60 thirds, &c. The artificial days are always unequal to all the inhabitants that are not under the Equator, except when the ſun is in the equinoctial points ♈ and ♎, which happens about the 21ſt of March, and the 22d of September;

tember; at thoſe times the ſun riſes and ſets at ſix, to all the inhabitants of the earth.

All nations do not begin their day and reckon their hours alike. In Great Britain, France, and Spain, and in moſt other countries in Europe, the day is reckoned to begin at midnight, from whence is counted 12 hours till noon, then 12 hours more till next midnight, which makes a natural day. Yet, even in thoſe countries, the aſtronomers commonly begin their day at noon, and ſo reckon 24 hours till next noon, and not twice twelve, according to the vulgar computation. The Babylonians began their day at ſun-riſing, and reckoned 24 hours till he roſe again. This way of computation we call the Babyloniſh hours. In ſeveral parts of Germany, they count their hours from ſun-ſetting, calling the firſt hour after the ſun has ſet, the firſt hour, &c. till he ſets the next day, which they call the 24th hour. Theſe are commonly called the Italian hours. According to both theſe ways of computation, their hours are either a little greater or leſs than the $\frac{1}{24}$ part of a natural day, in proportion as the ſun riſes or ſets ſooner or later in the ſucceeding days. They have alſo this inconvenience, that their midday and mid-night happen on different hours, according to the ſeaſons of the year. The Jews and Romans formerly divided the artificial days and nights, each into 12 equal parts: theſe are termed the Jewiſh hours, and are of different lengths according to the ſeaſons of the year; a Jewiſh day-hour in ſummer being longer than one in winter, and night-hour ſhorter. This method of computing time is now in uſe among the Turks, and the hours are ſtiled the firſt, ſecond, third, &c. hour of the day or night; ſo that mid-day always falls on the ſixth hour of the day.

There is nothing in nature that ſuggeſts the idea of dividing time into weeks; ſo that a week ſeems to be merely a civil or rather a religious inſtitution, as among all nations, that have any notion of religion, one day in ſeven is ſet apart for public worſhip. For this purpoſe Chriſtians obſerve Sunday, or the firſt day of the week; the Jews obſerved Saturday, or the ſeventh day of the week; and the Turks perform their religious ceremonies on Friday.

A month is properly that ſpace of time which is meaſured by the moon in her courſe round the earth. A lunar month is either periodical or ſynodical. A periodical month is the time which the moon takes up in performing her courſe from one point in the ecliptic till ſhe returns to it again, which is 27 days, 7 hours, 43 minutes, 4'' 45'''; and a ſynodical month, or (as it is ſometimes called) a lunation, is the time betwixt one new moon and the next new moon, which is 29 days, 12 hours, 44' 2'' 53'''. Therefore, though in the ſpace of a year the moon performs 13 revolutions round the earth, or completes 13 periodical months, and 10 days over; yet there are but twelve lunations, or ſynodical months, and eleven days over, in a year. There is a third kind of month, different from both the former: it is called the civil month, and conſiſts of a certain number of days, either more or fewer, according to the laws and cuſtoms of the country where ſuch months are obſerved.

The completeſt period of time is a year, in which all the ſeaſons return in ſucceſſion, and begin a new. A year is either aſtronomical or civil. An aſtronomical year again is either ſiderial or tropical. The ſiderial year is the ſpace of time that paſſes while the ſun goes from any fixed ſtar to the ſame again. It conſiſts of 365 days, 6 hours, 9' 14''. The tropical year is the ſpace of time that paſſes while the ſun goes from either tropic, or from any point of the ecliptic, to the ſame again. This is ſomewhat ſhort of the ſiderial year, becauſe every point of the ecliptic goes backwards about 50 ſeconds of a degree in a year, (owing to what is uſually called the preceſſion of the equinoxes) thereby meeting the ſun, as it were; which makes the ſun return to the ſame point of the ecliptic, about 20 minutes of time before he arrives at the ſame fixed ſtar from which he ſet out the preceding year. The tropical year, therefore, is ſhorter than the ſiderial year, and conſiſts of 365 days, 5 hours, 48' 57''. The civil year is the ſame with the political, and is that which is eſtabliſhed by the laws of any particular country.

Days, months, and years, however, were all of them originally very imperfect, as reſulting from very groſs obſervations; and indeed aſtronomy, in its infant ſtate, afforded no better means of computation. Nay, the year, as inſtituted by Romulus, the founder of Rome, conſiſted but of ten months, beginning with the month of March; but as this was ſhort of the ſun's period by two months, theſe were afterwards added by his ſucceſſor, Numa Pompilius, and were called January and February. By theſe means the Roman year conſiſted of 12 months. But the months of this year being lunations, or lunar ſynodical months, of 29½ days each, this civil lunar year conſiſted but of 354 days; but as the ſun, in revolving once through the ecliptic, was found, in proceſs of time, to take up 365 days, or 11 days more than the lunar year, theſe were added to it by the emperor Julius Cæſar, and on that account it was called the Julian year. The 11 days added, to render the lunar equal to the ſolar year, the Greeks called Epagomenœ, and hence their modern name *epacts*.

But the year thus conſtituted by Julius Cæſar, of 365 days, was obſerved by the aſtronomers of that age, to be about ſix hours ſhorter than the time the ſun took up in running through the ecliptic. The emperor, therefore, ordered, that every fourth year ſhould conſiſt of 366 days, in order that the ſeaſons of the year might be always fixed to the ſame parts of the calendar, and the feaſts and faſts be thereby rendered certain and invariable. This he did as Pontifex Maximus, or High Prieſt in the

Roman hierarchy. This odd day was in every fourth year added to the 24th of February. And, according to the Roman way of reckoning, was the *Dies ſextus ante kalendas Martii*, or the ſixth day before the firſt of March; ſo that there being then *bis ſextus dies*, or two ſixth days, gave occaſion for that year to be called *Annus Biſſextilis*, or Biſſextile year, which we now commonly call Leap-year.

In order to know whether any particular year be Leap-year or not, divide it by 4, and the remainder, if there be any, ſhews how many years it is ſince Leap-year; and, if there be none, then it is Leap-year. Or you may omit the hundreds and thouſands, and divide only the units and tens by 4, and the reſult will be the ſame. Example: Divide 1792 by 4, the remainder is 0; or divide only 92 by 4, the remainder is likewiſe 0; conſequently 1792 is Leap-year. Divide 1793 by 4, the remainder is 1; or divide only 93 by 4, the remainder is likewiſe 1; conſequently 1793 is the firſt year after Leap-year.

Six hours, however, were afterwards found to be too much by 11 minutes, 3 ſeconds, for ſo much does the ſolar or tropical year want of 365 days, 6 hours. By the addition, therefore, of ſix whole hours, the ſun each year began his courſe, or entered the firſt ſign of the eclipitic 11' 3'' before the preceding year was ended. This preceſſion of the ſun, as it may be called, or, as it is uſually termed, of the equinoxes, amounts to one whole day in

131 years. From Julius Cæſar to the Council of *Nice*, A. D. 325, was about 375 years. At that time the vernal equinox fell upon the 21ſt of March, and conſequently every 131 years after, the equinox muſt anticipate one whole day; therefore the ſeaſons of the year, and feſtivals of the church, muſt be rendered moveable, and in time go retrograde through the whole calendar. This ſoon alarmed the fathers of the primitive church, whoſe knowledge, or rather whoſe ignorance, of aſtronomy never ſuffered them to ſuſpect any ſuch thing: and as Eaſter (the principal feaſt) had been fixed to the Sunday which was the firſt after the new moon that happened next after the 21ſt of March, or vernal equinox, they ſaw with concern the unſtable condition of their rubric; and in the time of Pope Gregory XIII. this grievance had grown to ſo great a height, that the ſaid equinox, and Eaſter of courſe, had anticipated the time to which the fathers of the Nicene council ſuppoſed they had fixed it, no leſs than 10 days.

This Pope, therefore, convened a council of the beſt aſtronomers of that age, and after a minute examination of the matter, it was ordained, that ten days ſhould be taken from the month of October in 1582, by reckoning the 5th day as the 15th. And to prevent the regreſs of the equinoxes for the future, and conſequently any irregularity in the calendar, it was further ordained, that every hundredth year, which in the Julian account was a Leap-year, ſhould in this be only a common year, and conſiſt but of 365 days; but as that was too much, every four hundreth year was to remain a Leap-year or Biſſextile. This reformation of the calendar is called the Gregorian account, or New Stile; and according to this ſtile was the calendar rectified in England, in 1752, by throwing out 11 days in the month of September, as from the Council of Nice to that year 1427 years had elapſed; and, beſides, the beginning of the civil year was fixed to the firſt day of January.

FINIS.

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